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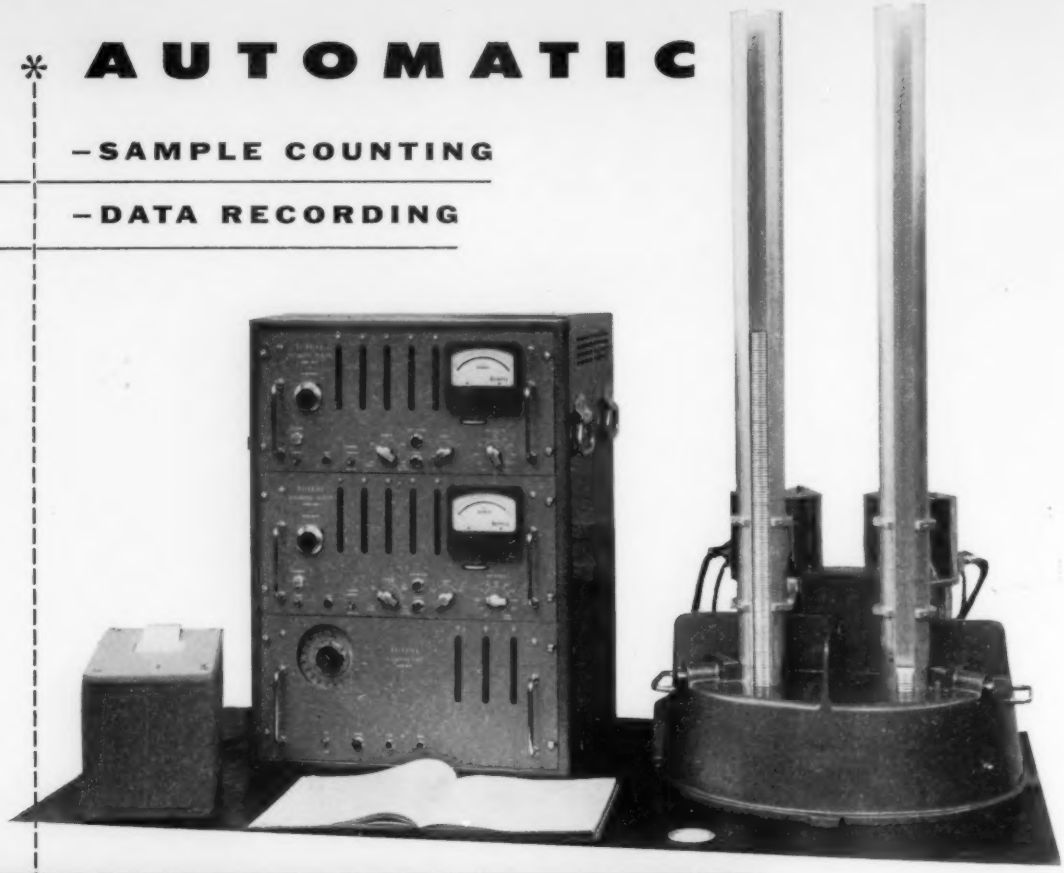

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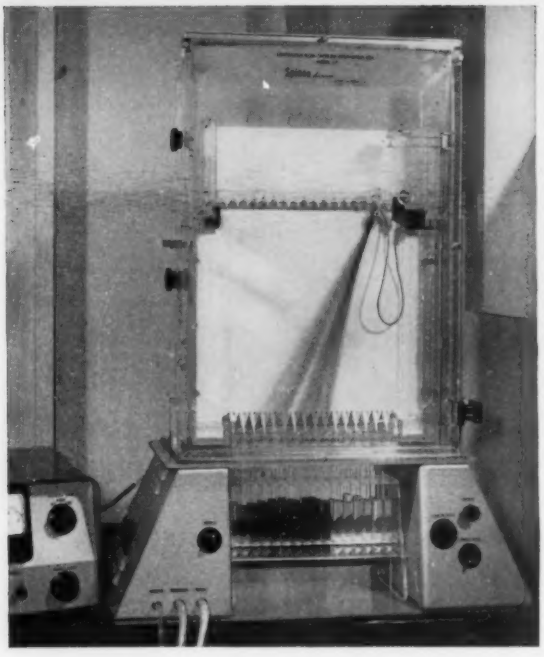

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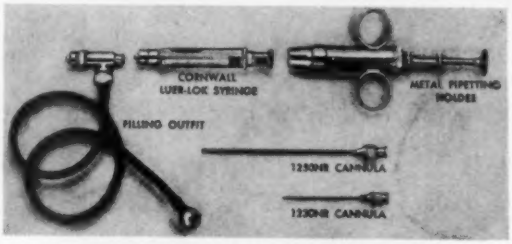

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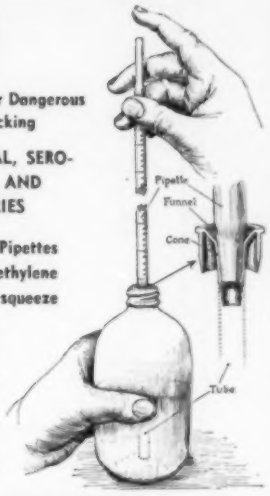

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The Scientist's Perspective

Who does not recognize today that the impact of science on society is truly overwhelming in importance, and that the future welfare, if not the very existence, of human society will depend increasingly upon the public understanding of science—not so much of the facts or even the concepts of science as an understanding of what science really is and how it yields its results? Scientists deplore the popular image of science as a benevolent genie who will provide any gift the Master of the Lamp may demand, or the popular conception of scientific method as a sort of "intellectual machine that inevitably grinds out ultimate truth in a series of orderly, predictably sequential 'steps,' with complete accuracy and certainty" [H. K. Schilling, in a paper presented at a meeting of Section L of the AAAS in Atlanta]. Nevertheless, few scientists care to undertake the labor of explaining the real nature of science; in fact, but few of them take time to think the matter out for themselves. The philosophy of science and the history of science are glaringly neglected by the very practitioners of science itself.

The result is a fatal blindness that afflicts most of those who write the scientific textbooks that introduce college and university students to their fields. Nine out of ten of these books, in my experience, present their science as a series of established facts and polished generalizations—*obiter dicta* handed down in an authoritarian fashion. How rarely does one find any evaluation of evidence or any description of the experimental means whereby the evidence was gathered. How trebly rare to get any hint of the errors and confusions and false starts of able scientists, or any indication that the "truth" of today is so often a synthesis of views once held to be mutually contradictory (for example, epigenesis and preformation in the formation of the embryo; the corpuscular and the wave theories of light). Is it any wonder that our younger scientists, fed on such a distillate, lack the perspective that becomes more and more necessary to interpret science to the public, which benefits from it and supports it, but has no firsthand acquaintance with it?

While listening during the December meetings to a symposium of the History of Science Society, on the occasion of the first presentation of the Sarton medal to George Sarton himself, I heard papers on "The origin and diffusion of the crank" (Lynn White, Jr.) and on "The theory of the rainbow: medieval triumph and failure" (Carl B. Boyer) that fully illustrated the dependence of scientific discovery on the intellectual "atmosphere" of the times, and the failure of discoveries to be appreciated because they were ahead of the scientific thinking of the day. I was struck by the obvious need to give more attention to the nature of science and scientific methods. Yet at the same time I felt dismay that the history of science is so dominated by historians and, I might add, the philosophy of science by philosophers, while the contributions made by practicing scientists to either field are relatively few.

Science is a typically human, typically social, indeed typically communal enterprise. To perform good experiments and make logical interpretations of our data are not enough. To teach facts and theories in an authoritarian way vitiates the spirit of science. We are part of a living, developing community of science, and only by paying heed to our past and considering our foundations can we fulfill our social responsibility.—BENTLEY GLASS, *Johns Hopkins University.*

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SCIENCE

Current Status of Theories of Hearing

Georg v. Békésy

By the middle of the 19th century a large number of theories of hearing had been proposed (*1*). At that time the main problem was to determine which part of the inner ear is set in vibration by sound waves. Since very little was known of the anatomy of the inner ear, the possibilities for theorizing were almost limitless, and the confusion became so great that, it is said, some lecturers in physiology simply did not treat the topic of hearing at all. After 1863, however, when Helmholtz proposed his resonance theory of hearing, the topic could no longer be ignored.

Helmholtz' theory was successful because it was based on anatomic and physical facts. When the cochlea was laid open in earlier times by cracking the temporal bone or chiseling away the bony wall, a half-dry gelatinous mass was found. It was not even clear whether the cochlea was filled with fluid or not. In my opinion, it was P. F. T. Meckel who performed the first basic experiment in the physiology of hearing when, in 1777, he opened the cochlea of a cat under water. He found no air bubbles coming out of the cochlea, thus proving that it is filled with fluid.

After histologists had found that a fixative acid would hold the gelatinous mass in its natural position, the anatomy of the inner ear could be worked out in detail by Corti, Hensen, and others. With this increased knowledge of the anatomy of the inner ear, Helmholtz and Hensen were able to conclude that the sensation of hearing is determined by the vibrations of the basilar membrane, a conclusion that is still generally accepted.

The author is on the staff of the Psycho-Acoustic Laboratory at Harvard University.

The next problem was, How does the basilar membrane vibrate? Helmholtz thought that the tension of the basilar membrane is greater transversely than longitudinally. Since it was known that the width of the membrane changes continuously from one end of the cochlea to the other, he concluded that it should behave like a set of resonators whose tuning changes continuously from one end to the other. The pitch discrimination of the ear could thus be accounted for since every frequency would bring a different resonator into vibration. Helmholtz' theory of pitch discrimination was not generally accepted, and the question of how the basilar membrane vibrates became and continues to be an issue. The various answers proposed have been presented as theories of hearing.

In my opinion, the words *theory of hearing* as commonly used are misleading. We know very little about the functioning of the auditory nerve and even less about the auditory cortex, and most of the theories of hearing do not make any statements about their functioning. Theories of hearing are usually concerned only with answering the question, How does the ear discriminate pitch? Since we must know how the vibrations produced by a sound are distributed along the length of the basilar membrane before we can understand how pitch is discriminated, theories of hearing are basically theories concerning the vibration pattern of the basilar membrane and the sensory organs attached to it.

The problem under discussion is a purely mechanical one, and it may well seem, at least to the layman, that it can easily be solved by looking at the vibration patterns in the cochlea. Unfortunately, this direct approach proves difficult, for without stroboscopic illumination and other special devices, we can observe almost no vibration in the nearly transparent gelatinous mass in the cochlea of a living organism.

Furthermore, the maximal physiological vibration amplitudes of the basilar membrane can be seen and measured only when they are magnified between 100 and 300 times. Although observations have been made with this magnification (*2*), it is important to find other methods of observing the vibration pattern of the basilar membrane. Since hearing is the common concern of many disciplines—physics, engineering, physiology, psychology, zoology, and even mathematics—it is understandable that a great variety of solutions have been proposed. Naturally, each investigator has thought primarily in terms of his own field, and it was forgotten, for example, that vibration patterns are really a physical problem and not a musical one.

Various Vibration Patterns of the Basilar Membrane

Reports of the various vibration patterns of the basilar membrane that have been proposed thus far are to be found in textbooks on the psychology of hearing (*3*). These reviews point up the differences between the various hypotheses, and some of them are very critical. Indeed, they are so critical that they give the impression that the psychology of hearing is nearing the end of its productive period and entering a phase of unconstructive criticism. I would like to show in this paper, therefore, how the various hearing theories are interrelated and how by manipulating two independent physical variables of the basilar membrane—absolute stiffness and coupling of adjacent parts—we can obtain a continuous series of vibration patterns, each group of which is in agreement with one of the four major theories of hearing. We may proceed continuously from curves predicted by the resonance theory to curves predicted by each of the other three theories in turn. It is thus shown that the various theories form one continuous series of vibration patterns.

A schematic cross-section of the ear is presented in Fig. 1. Sound enters the external meatus and sets the tympanic membrane in motion, and the vibrations

are conducted through the ossicles to the fluid in the cochlea. The basilar membrane, which acts as a partition between the two channels, is set in motion by any movement of the ossicles. Since the fluid is incompressible, the fluid displacement produced by the stapes is equal to the deformation of the round window. The question is, then, How is the basilar membrane displaced and how does it move during a sinusoidal vibration of the ossicles?

Although the movement of a membrane depends on other factors as well, we shall turn our attention first to the elastic properties of membranes. Three elastic properties of the membrane in a cochlear model can be varied: the absolute value of stiffness; the slope of stiffness along the length; and the coupling between adjacent parts.

1) The absolute value of the stiffness of the membrane can be changed. If the membrane is stiff, a pressure difference across the membrane causes only a small displacement or deformation.

2) The stiffness of the membrane can be constant, or it can vary along the whole length. The basilar membrane is stiffer near the stapes than it is near the helicotrema; for man and most other vertebrates, the stiffness near the stapes is about 100 times greater than it is at the other end.

3) The coupling between the adjacent parts of the membrane can be varied. In a membrane made of thin elastic fibers stretched across a frame, when there is no coupling between one strand and its adjacent strands, each strand can vibrate freely. The strands can be coupled by a thin sheet of rubber placed along the whole set. The coupling becomes larger as the thickness of the rubber sheet is increased. A membrane can also be made of a smooth sheet of rubber alone, without individual strands.

These three possibilities may be expressed mathematically by saying that we have three independent variables for the elasticity of the membrane.

There are two methods for investigating the effect of manipulating these variables on the vibration pattern of a membrane. First, we can calculate the vibrations. Unfortunately this is a time-consuming job. Or second, we can construct a model of the cochlear membrane and vary its elastic properties. I have made models the size of the human cochlea and models that were larger. The enlarged models were constructed in the same way that full-scale ships are constructed from small-scale models. As is well known, this kind of dimensional enlargement has proved quite successful.

Figures 2 and 3 show some of the effects that are obtained by varying the elastic properties of the membrane. Figure 2a shows a small section of the membrane model consisting of coupled strands acted on by a point force (needle tip). The absolute value of the elasticity of the different strands varies continuously from 100 to 1 from left to right along the membrane. Seen from the top, the deformation pattern is a group of elongated ellipses, the deformation spreading neither to the left nor to the right. The side view shows this limited lateral spread even better. This model simulates the system of almost freely vibrating elastic resonators that is postulated by the resonance theory of hearing. If we immerse this membrane in fluid, the vibration pattern seen in Fig. 3a is obtained for a steady tone.

With the same slope of elasticity and the same driving frequency, but with an increase in the absolute value of the membrane stiffness, a steady tone causes the whole membrane to vibrate in phase (all parts of the membrane reaching their maximal elongation simultaneously), in the manner of a telephone diaphragm, as shown in Fig. 3b. This is the pattern of vibration assumed by the telephone theory of hearing. The vibration pattern

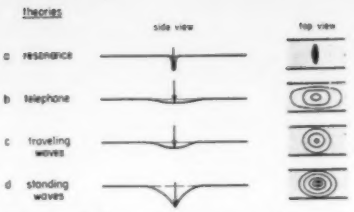

Fig. 2. Deformation patterns in membranes acted upon by a point force.

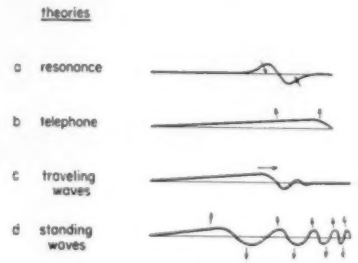

Fig. 3. Vibration patterns in membranes for a continuous tone (with normal damping). The arrows indicate the direction of movement at a given instant.

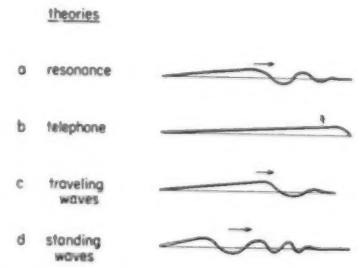

Fig. 4. Vibration patterns in membranes for the transient state (with normal damping).

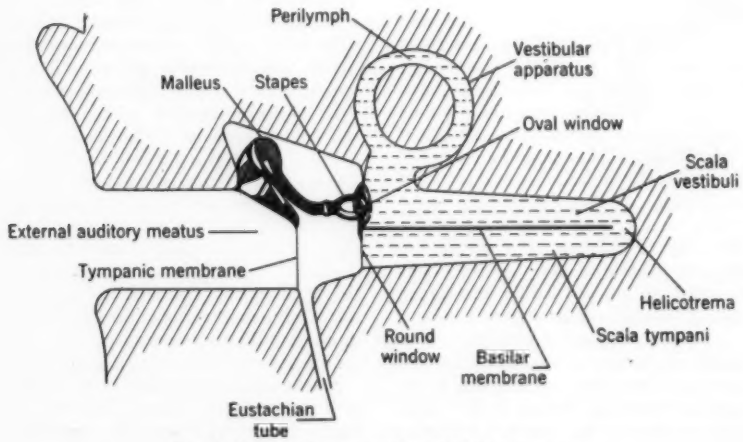

Fig. 1. Schematic cross-section of the human ear.

for the steady tone is independent of the coupling between adjacent parts of the membrane because the whole membrane vibrates in phase, with no force acting laterally. Because of the increase in stiffness, the same point force that was used before now produces a smaller deformation (Fig. 2b); if the rubber strands are replaced by a flat plastic sheet that is stretched and clamped along the two long sides to the frame of the model, the point force produces the same lateral spread.

We obtain substantiation of two other types of hearing theories simply by decreasing the thickness of the plastic sheet. As the thickness decreases, the maximal amplitude of the displacement becomes greater. When the thickness of the sheet is decreased slightly, the same steady tone produces a traveling wave moving away from the source (Figs. 2c and 3c). When a thinner sheet is used, the same point force pushes the partition out still

farther; and the same steady tone produces traveling waves that get shorter and travel farther until some are reflected from the end of the membrane and standing waves result (Fig. 3d). The standing-wave theory was proposed by Ewald.

A change in the frequency of a steady tone moves the maximum of the vibrations along the basilar membrane, as the resonance theory assumes. An increase in the frequency moves the maximum of the vibrations toward the stapes. The resonance theory of hearing is a place theory in which pitch discrimination depends on locating the place along the membrane that is set in maximal vibration. According to the telephone theory, a change in frequency need not affect the displacement of the membrane, and pitch discrimination depends on some unknown function of the brain. The traveling-wave theory is also a place theory, since an increase in the frequency moves the maximum of the vibrations toward the stapes, and a decrease moves it toward the helicotrema. According to the standing-wave theory, an increase in frequency increases the number of nodes and decreases the distance between them. The brain uses this information to determine pitch.

As we can see from Fig. 3, four basically different vibration patterns can be obtained for a steady sinusoidal tone simply by manipulating two variables, the absolute stiffness of the membrane and the coupling between its adjacent parts. Since it is possible to go continuously from one pattern to another, an infinite number of intermediate patterns can be obtained; but all these belong to a single family of curves. Additional vibration patterns have been proposed, some of which I have tried to verify on models, but I have come to the conclusion that they are only drawings and have no physical existence. I believe that Fig. 3 shows all the principal patterns there are.

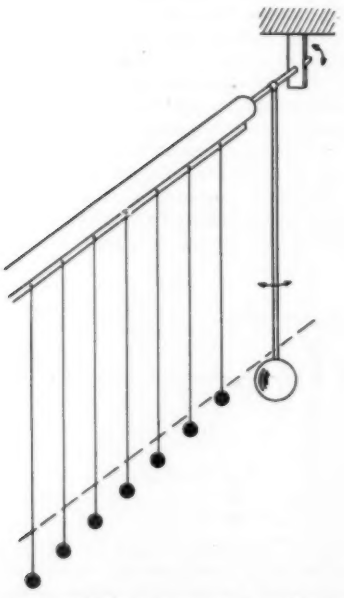

Fig. 5. Pendulum system set up to demonstrate occurrence of traveling waves in a system of free resonators.

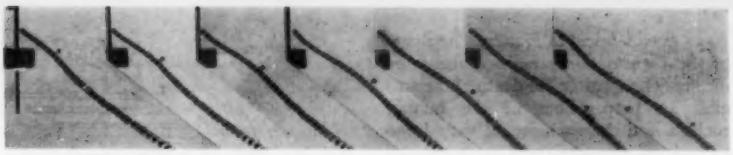

Fig. 6. Film strip showing a system of free resonators with wave traveling toward the longer pendulums (from right to left) during the onset of a continuous tone. The black dots indicate the positions of the maximal lateral displacement.

We have seen how, for a continuous tone, it is easy to substantiate each theory in turn simply by manipulating the elastic properties of the membrane. The differences among the theories depend wholly on the sizes of these variables. It is even more surprising, however, to find that for transients—for example, the onset of a steady tone—the differences between the resonance, traveling-wave, and standing-wave theories disappear completely, despite the emphasis that these differences have received. Traveling waves develop during the onset of vibrations in membranes whose vibration patterns are described by these three theories, as shown in Fig. 4. (The driving frequency is the same as it is in Fig. 3.) Only the telephone theory assumes that all parts of the membrane vibrate in phase, in complete conformity with the movements of the driving stapes.

It is especially difficult to understand how in a system of free resonators the onset of a continuous tone produces traveling waves. A simple experiment was set up to demonstrate the occurrence of traveling waves in a system of free resonators (Fig. 5). A pendulum with a large mass was clamped to a long, horizontal driving rod from which a series of small pendulums was suspended. The lengths of the pendulums increased continuously from one end of the system to the other, from right to left in the figure. One pendulum in the middle of the series was of the same length as the heavy driving pendulum. During continuous oscillation of the driving pendulum, the resonant pendulum was set in motion by small movements that were transmitted through the oscillating supporting rod. A change in the period of the driving pendulum made a different pendulum resonate—that is, the whole series was a system of free resonators, each of which resonated at a different frequency. The onset of the oscillations of the driving pendulum set in motion a large section of the system, and a traveling wave was observed moving toward the longer pendulums, as can be seen in the sequence of film shown in Fig. 6.

To complete this survey of the various hearing theories, I should mention that at very low frequencies the movement of a vibrating system is independent of its mass; the displacement of the various parts of the membrane is determined solely by their elasticity. Since the slope of elasticity along the membrane is the same in all four models, the vibration patterns for low frequencies are similar, as shown schematically in Fig. 7. The largest excursions appear in the standing-wave model, which has the most yielding membrane.

Another factor that affects the movement of the basilar membrane is the damping provided by the fluid in the cochlea. In our models, when the viscosity is high, the differences between the various theories tend to disappear. When the fluid friction is extremely high, the movements of the membrane are determined solely by the frictional forces in the fluid, independent of the elasticity values of the membrane. Here again the vibration patterns are identical for all the theories, and even the displacements are equal (Fig. 8).

According to the foregoing discussion, the question of which hearing theory is valid reduces to the more easily answered question, What are the numerical values of the elasticity and coupling along the basilar membrane? In these experiments, when the tip of a needle was pressed perpendicularly on the surface of the basilar membrane of some lightly anesthetized vertebrates (guinea pig, mouse, cat, and pigeon), the resulting deformation was almost circular; both the top and side

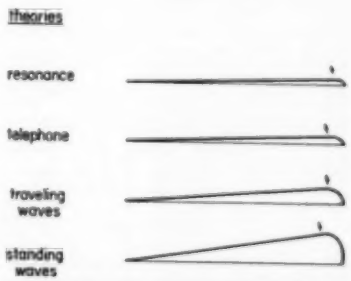

Fig. 7. Vibration patterns in membranes for continuous tones of very low frequency.

views are identical to Fig. 2c. The shape of the deformation remained the same for many hours after the death of the animal. In preparations of the human cochlea and the cochleae of very large animals such as cattle and elephants, the same circular deformation is found. The shape of the deformation proves that the coupling between the adjacent parts of the basilar membrane is so large that it invalidates the resonance theory of hearing.

The side view of the deformation makes it clear that the stiffness of the basilar membrane is too great for standing waves to occur. The formation of standing waves along the basilar membrane is improbable also because standing waves with large amplitudes occur only at certain frequencies; if standing waves were to occur, the sensitivity of the ear would undergo large fluctuations during a continuous change in frequency. Figure 9 shows the type of audiogram we would obtain under these conditions.

It is clear, therefore, that the vibration of the basilar membrane cannot be accounted for by either the resonance theory or the standing-wave theory.

Observation of the basilar membrane in mammals substantiates the traveling-wave theory. Under stroboscopic illumination, a steady tone of 1000 cycles per second produces traveling waves similar to those pictured in Fig. 3c. When the frequency is lowered, the maximal amplitude moves toward the helicotrema (toward the right side of Fig. 3c), and

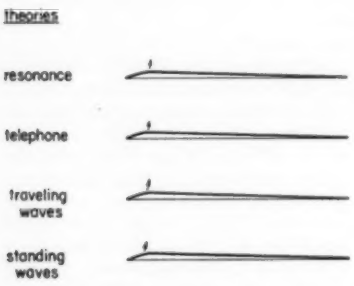

Fig. 8. Vibration patterns in membranes immersed in fluid with very high viscosity (for continuous tones).

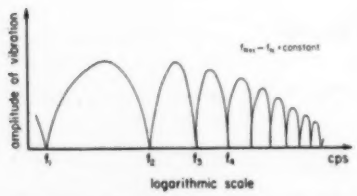

Fig. 9. Hypothetical audiogram for standing-wave theory showing large fluctuations which would occur during a continuous change in frequency.

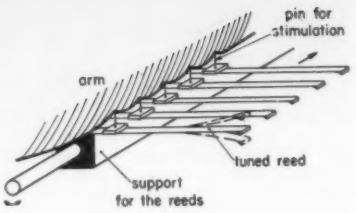

Fig. 10. Mechanical model for the resonance theory, with the skin of the arm substituted for the nerve supply of the basilar membrane. The reed system transforms any change in frequency into an easily observable displacement of the stimulated area on the skin.

the length of the membrane that is vibrating practically in phase is increased. The place of the maximum reaches that end of the membrane in the different animals at the following frequencies: mouse at 400 cycles per second, pigeon at 80, rat at 180, guinea pig at 200, man at 30, and elephant at 30. Below these frequencies the basilar membrane vibrates in phase, as postulated by the telephone theory (Fig. 3b).

Below the critical frequency, pitch discrimination depends entirely on the temporal sequence of the stimulation of the nerves. Above the critical frequency, there is a second factor, the shifting of the place of maximal stimulation along the basilar membrane. We must now ask, Is pitch discrimination improved by this shifting of the place of maximal stimulation as compared with the conditions under which it depends wholly on the temporal sequence of the vibrations? The problem is no longer mechanical, but one of how the nerves react to different vibration patterns on the basilar membrane.

Mechanical Models of the Cochlea

In order to investigate this aspect of the problem, I built cochlear models in which the skin of the forearm was substituted for the nerve supply of the basilar membrane. Three mechanical models were made that stimulated the skin of the arm in accordance with the three vibration patterns in Fig. 3a, b, and c. No model with standing waves was built because change in frequency would produce a large change in amplitude, and consequently it would be very difficult to distinguish amplitude changes from frequency changes (which is not the case in the ear).

The mechanical model for the resonance theory is shown in Fig. 10, for the telephone theory in Fig. 11, and for the traveling-wave theory in Fig. 12.

The resonating model consisted of a series of tuned steel reeds attached to a metal support that oscillated slightly around its longitudinal axis. The length of the support was equal to the length of the forearm. Thirty-six reeds, tuned in equal intervals over a range of two octaves, were distributed along the whole length. A small pin on each reed, fastened close to the support, touched the surface of the skin of the arm. The pins had rather small points, so that the skin would not pick up too much energy from the vibrating reeds; otherwise it would not have been possible to obtain a sharp resonance of the reeds. When the arm is placed carefully along the pins, so that the points just touch the skin, the reed system transforms any change in frequency into an easily observable displacement of the stimulated area on the skin.

The model for the telephone theory is a triangular metal frame made of tubes (Fig. 11). The frame vibrates perpendicularly to the axis of the edge in contact with the forearm. The rigidity of the frame insured that all the stimulating parts touching the skin would vibrate in phase. From time to time, phase constancy along the frame was verified by stroboscopic illumination.

The model for the traveling waves was a section of a model of the human cochlea, enlarged by dimensional analysis. The frequency range was two octaves. The model was a plastic tube cast around a brass tube with a slit. The tube was filled with fluid. Figure 12 shows the position of the arm on the vibrating membrane. A vibrating piston sets the fluid inside the tube in motion, and forces in the fluid produce waves that travel from the hand to the elbow. The traveling waves thus produced are similar to those observed in preparations of human cochlea. The maximum amplitude of vibration is rather broad, and when it is observed under stroboscopic illumination, it moves along the membrane as the frequency is changed. Although the maximum is quite flat as it moves along the arm, the sensation of vibration is concentrated on a relatively short length (about 2 to 4 centimeters); hence, any frequency change is easily

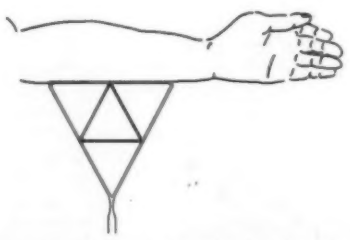

Fig. 11. Mechanical model for the telephone theory, with the skin of the arm substituted for the nerve supply of the basilar membrane. All parts of the triangular frame in contact with the arm vibrate in phase.

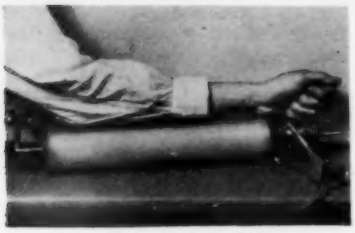

Fig. 12. Mechanical model for the traveling-wave theory, with the skin of the arm substituted for the nerve supply of the basilar membrane. A vibrating piston sets the fluid in the tube in motion, producing waves traveling from the hand to the elbow.

recognized by a shift in the stimulated area. Seemingly the nerve network in the skin inhibits all the sensation to either side of the maximum of the vibration amplitude, thereby producing a sharpening of the stimulated area.

If we compare the three models, we find that the difference limen for "pitch" discrimination below 40 cycles per second is the same because the skin is able to discriminate the roughness of the vibrations as such. But for higher frequencies, displacements of the sensation along the arm, produced either by the resonating model or the traveling-wave model, permit much more accurate frequency discrimination than the telephone-theory model does.

The most surprising outcome of these experiments with models was that pitch discrimination did not deteriorate when the presentation time of the tone was very short. Even when the stimulus was only two cycles, the pitch discrimination for both the resonance model and the traveling-wave model was just as good as it was for a continuous tone of longer duration. Closer examination showed that in both models the place of maximal amplitude was determined during the first two cycles of the onset of a tone. Figure 4 shows that for transients there is very little difference between the vibration patterns of the resonance and traveling-wave theories. In both, waves travel over quite a long section of the vibrating system. The surprising fact is the inhibitory action of the nerve supply, which suppresses all sensation except on a small spot near the maximal amplitude of vibration. In the ear the situation seems to be the same because, there too, two cycles of a tone are enough to enable us to discriminate the pitch of the tone.

Summary

In summing up the current status of the hearing theories, it may be said that each of the vibration patterns of the basilar membrane postulated by the four major theories of hearing can be obtained by varying two elastic properties of the membrane—namely, the coupling between adjacent parts and the absolute value of the elasticity. If these two variables are adjusted to their numerical values in the cochlea of a living animal or a fresh preparation of the human ear, traveling waves are observed along the membrane. These traveling waves have a flat maximum that shifts its location along the membrane with a change of frequency—the place of the maximum determining the pitch. An enlarged dimensional model of the cochlea in which the nerve supply of the sensory organs on the basilar membrane was replaced by the skin of the arm indicates that the inhibitory action in the nervous system can produce quite sharp local sensations, which shift their place with changes in the frequency of the vibrations.

References and Notes

1. This article is based on a lecture given at the meeting of the American Otological Society in Chicago on 10 October 1955. The enlarged model of the cochlea was demonstrated at that meeting. Those present were able to try out the model for themselves and to observe the change in location of the stimulated area on the skin when the driving frequency of the model was changed. This article was prepared under contract N5ori-76 between Harvard University and the Office of Naval Research (project NR142-201, report PNR-179).
2. Articles of mine that are concerned with measurement of the vibration pattern of the human cochlea have appeared in the main in *J. Acoust. Soc. Amer.* from 1947 to the present.
3. S. S. Stevens and H. Davis, *Hearing: Its Psychology and Physiology* (Wiley, New York, 1938); E. G. Wever, *Theory of Hearing* (Wiley, New York, 1949); O. F. Ranke, *Physiologie des Gehörs* (Springer, Berlin, 1953); E. G. Wever and M. Lawrence, *Physiological Acoustics* (Princeton Univ. Press, Princeton, N.J., 1954); and T. C. Ruch, "Audition and the auditory pathways," in Howell's *Textbook of Physiology*, J. F. Fulton, Ed. (Saunders, Philadelphia, ed. 17, 1955), pp. 399–423. For additional titles see S. S. Stevens, J. C. G. Loring, D. Cohen, *Bibliography on Hearing* (Harvard Univ. Press, Cambridge, Mass., 1955).

Secrecy and Scientific Progress

Lloyd V. Berkner

Serious technological secrecy is relatively recent, having emerged sharply as a product of the upsurgence of our technological revolution. There are, of course, a few earlier examples extending throughout history, but they were almost insignificant. But as society generally has become deeply dependent on technological development, so too have the military organizations increased their dependence on science and technology. Initially, at least, it appeared reasonable that the military should restrict the exchange of ideas having military implications on the ground that to permit the free flow of information would hand the enemy our developmental achievements "on a platter."

In the modern world, however, all the important areas of science have military implications and, under our present policies, must therefore fall inevitably under the cloak of military secrecy. Not long ago, for instance, a responsible scientist mentioned to me that he had endeavored to arrange a scientific conference on fundamental high-temperature physics. He found that this was impossible, however, because all the important recent advances were "classified information." At the same time, Marguerite Higgins has reported in the New York *Herald Tribune* for 6 February 1956, "An Indian engineer told me, for example, that Soviet development of heat-resistant materials was far more advanced than anything he had seen in the West." A great many such examples can be cited. Since more and more of our scientific activity is coming within the purview of secrecy, the need for appraisal of the effects of secrecy on our scientific stature and progress, and therefore on our national security, becomes of increasing importance. It

Dr. Berkner is president of Associated Universities, Inc. This article is based on his statement to the Government Information Subcommittee of the Committee on Government Operations, House of Representatives, on 7 Mar. 1956.

seems highly probable that a little technological secrecy, like a little poison, may be a good thing, but too much can destroy us. Therefore, it is important to understand just where the balance lies.

A famous psychologist at the University of Michigan once pointed out to me that creative thinking is the reassociation of old ideas in new ways. The really significant new concepts of science are often, if not always, the result of association of widely diverse facts and ideas that may not hitherto have seemed remotely connected. Such ideas as the laws of mechanics and the concepts of space and time derived from astronomy, together with the work of Planck on high-temperature radiation, led Einstein to postulate the equivalence of mass and energy. On this concept is based the development of nuclear energy. Yet today, any intelligent military organization, operating under the present security rules, would certainly classify the equivalent of Planck's work so that it would be denied to a potential Einstein.

In the same way, it is necessary to understand how the benefits of science to our nation will quickly be extinguished by widespread technological secrecy. In suppressing seemingly isolated scientific bits of information of direct military value, we prevent, at the same time, the germination of scientific ideas of much greater scientific, social, and military significance. The great concepts generated from a free and virile science and injected into our industrial complex can provide far greater security through technological supremacy than we could ever hope to achieve through the classification of technological information.

Beginnings of Secrecy

The application of serious secrecy to military technology seems to have coincided with the discovery of radar about 1930. During the ensuing decade, the results were not impressive. In the case of radar, secrecy seriously delayed its development, and neither technical nor tactical progress was very appreciable. As a consequence, although it was technically and demonstrably adequate to have done this relatively simple job, radar failed to prevent Pearl Harbor (a tactical failure born of military ignorance that was imposed by secrecy, for the clear warning of radar was ignored). Had we made known our radar protection of Pearl Harbor, there is at least a reasonable doubt that the Japanese would have attempted a surprise. In any event, our own commanders certainly would not have been ignorant of the powerful tools at their command, and the outcome might well have been very different.

Moreover, the development of airborne-radar applications awaited the war, for at its beginning we had no antisubmarine radar, no night fighters, no means for extensive sea search. The absence of such weapons is directly attributable to the technological ignorance and delays that resulted from secrecy. Had airborne radar been developed and advertized openly, the consequent great progress in these developments might have so weakened the German confidence in their submarine supremacy, or in their capabilities for strategic air attack, that the war might not have occurred. In any event, our shipping losses after its beginning would certainly have been less than the tragic millions of tons.

More recently, the establishment of our northern air defenses was delayed by at least 1, and more probably 2 years by technological secrecy. In fact, the security of information was so good that even the chairman of the Joint Chiefs of Staff did not learn, until after his retirement, that the main underlying technological problems had been solved more than 2 years earlier.

Is there anything in this history to lend confidence in the security that is provided by technological secrecy as contrasted to the security that is provided by progress?

We must understand clearly that, in applying technological secrecy on an ever-growing scale after 1930, we had no previous experience on which to rely, for it arose from a situation new to society and to armies. We did not then understand that technological secrecy is quite a different matter from the secrecy of tactics and battle order, of communication codes, of intelligence, and of intentions. Since that time, our experience with technological secrecy has grown, and it is now time to revise our policies in the light of the consequences that can be read with ever-increasing clarity.

Effect of Present Security Procedures

The maintenance of the widespread secrecy of technological information makes necessary the employment of procedures and regulations for the security of such information. Under these procedures, the scientist cannot avoid becoming the almost unique target, for he is the source of much of the information that is to be protected. It is his creative thought that produces the need for technological secrecy. Yet the application of our present security procedures conditions the scientist to avoid contact with any idea that may lead to military application. Why should this be true? The reasons seem clear.

1) If the scientist knows no "secrets," he cannot be involved in security questions. Scientists are no different from anyone else in desiring to protect their reputations. Once they are involved in secret matters, their reputations may be destroyed by any person who makes irresponsible charges. Because many people accept the cliché, "Where there's smoke, there's fire," subsequent clearance does little to undo the damage.

2) Clearance is not a permanent status, and a scientist's reputation is constantly susceptible to multiple jeopardy. Having once been admitted to secret information or having even originated it, the scientist knows that he may be destroyed by a subsequent change of policy or by other irrelevant circumstances that may result in suspension of that clearance. During each clearance review, his entire life comes under scrutiny, and any act or indiscretion that may have had no relevance to security at the time may arise to damn him. The threat of a review of his security clearance can be used to discourage his exploration of possible alternatives for the correction of national weaknesses—if these alternatives happen not to coincide with current policy.

3) In the process of reassociating ideas in new ways, the scientist must acquire from many sources the ideas to be associated. The development of a new concept does not occur in a flash, but is the consequence of hard thinking and long discussions with scientists of other views and of varied experience. Yet, if the emergent idea is of subsequent military importance and is later classified, the scientist may become involved in security procedures because of the earlier discussions of his own ideas that were an essential precedent to generating the new concept in his own brain.

4) If a scientist has been engaged in scientific leadership in the national interest, he is inevitably involved in extensive security questioning relating to his colleagues, to the views of his colleagues, to his estimate of their intent, and to their statements and actions at informal scientific conferences. He must act as witness at security hearings or render sworn statements concerning events long since past. He may unwittingly and quite improperly involve another through some misinterpretation of his meaning or error in his recollection. The application of security procedures becomes a harassment to all involved.

5) If a scientist expresses a strong view on some technological matter that may be contrary to the application of technology to current or to subsequent policy, he is open to the accusation of taking this view with the intent of deliberate subversion. If, as a consequence of study, he finds a serious deficiency in our military position and advocates a course of action to correct that deficiency, he

may be accused of conspiracy against the existing, though inadequate, policy. Moreover, secrecy prevents him from stating the essential technical grounds on which his view is based. Therefore, in the simple process of doing his job for his country well, he is open to damaging criticism against which he is permitted to produce little defense.

6) In a system of widespread technological secrecy, the scientist finds it increasingly difficult to sort out from the tremendous multiplicity of facts those that are secret and those that are open. He may not even know that a scientific fact, obvious to him, is classified as secret somewhere in the system. Consequently, his knowledge of secrets tends to restrict productive scientific discussions far beyond the necessity of the security system. But, if he errs, he must be certain to err on the side of safety. Therefore, the freedom of discussion, on which the maintenance of his professional competence depends and from which really great scientific progress emerges, is severely hampered.

7) The clearance procedure itself is complicated by a requirement that numbers of detailed forms be submitted to a multiplicity of agencies at frequent intervals. Clearance involves intolerable red tape and loss of much time and energy.

The situations that I cite are not hypothetical; each one can be documented by specific cases. The point is that the security process strongly conditions the scientist *not* to do those very things that most need to be done to preserve the technological supremacy of our country. Under these circumstances, we have lost the spontaneous will and opportunity for men to contribute to our strength when they possess special knowledge and the vision to see how it can be applied. Responsible men recognize the conditioning and will not consciously permit it to stand in the way of their duty and responsibility to their country and to the ideals that it represents. But repeated applications of these security procedures make the average scientist feel a little like the dog in the psychological experiment who is kicked every time the bell is rung. Presently, he runs quite unconsciously when the bell of "military security" is rung, without waiting for the kick. There is a limit to the frustrations experienced by the really creative scientist beyond which his creativeness is destroyed irrespective of his willingness to serve. The scientist who originates and works with secrets—and this includes most of them—is subjected to pressures and influences that are not experienced by other Americans. The scientists are not asking for preferential treatment, but for a relief from distracting pressures that are unknown to most other Americans—a relief that is imperative if scientists are to keep the United States abreast of scientific progress.

I do not say these things in criticism of the security system. As long as we have widespread technological secrecy as a national policy, I doubt that these defects in its application can be avoided; nor does their existence excuse any violation of either the spirit or letter of security procedures. I point out these defects in order that we may understand the consequences of technological secrecy. The proper balance between security derived from secrecy of technological information and security derived from progress must be understood clearly.

There is one other point that we cannot escape. An important concept in science is no less important to our national security because it is produced by one who cannot be "cleared" by the arbitrary application of security procedures. We must not forget that Hitler and Mussolini abrogated their right to the atomic bomb when they indulged in the doubtful extravagance of driving a few leading scientists from their shores because they could not be cleared according to Nazi or Fascist lights. Scientific greatness always rises from diversity of thought, never from conformity. Since the security procedures that support technological secrecy inevitably put a premium on conformity, they tend to prevent our nation's realization of the very greatness that we seek. For technological secrecy tends to obscure the essential dependence of democracy on diversity of thought and opinion. In the atmosphere of conformity, induced by our present neurosis, the encouragement of the diversity on which our system of free enterprise depends has been sometimes considered a form of subversive activity bearing on a man's security clearance, despite constitutional guarantees. An agile brain that can create great things is almost certain to be nonconformist.

The effect of the clearance procedure goes far beyond the protection of secrets. There is the case of one of our great chemists, a Nobel laureate, who was directing his learning to the synthesis of a suitable blood substitute. If a blood substitute could be found, this man with his superb skill could find it. Because of irresponsible charges from undisclosed sources, the support of his work was cut off by a nonmilitary agency of the Government. No formal charges were made; no hearing was possible since the work was not secret. There was no opportunity to clear these charges. Here we must ask ourselves, is it better for our security that the work of this man be cut off, or that we have the means of saving thousands of lives on the battlefield (and millions of lives at home should atomic attack ever come)? The lowest levels of personal clearance, such as the Atomic Energy Commission's "P" approval, or files check, and its military equivalents on men who are doing nonsecret work, are the most dangerous devices ever introduced in democracy. For the individual can be and often is blacklisted without recourse or even knowledge of it.

Balance between Secrecy and Free Information

Therefore, technological secrecy tends to put many of our best thinkers behind a wall across which they have no communication with our Government. Moreover, this wall excludes many of the great foreign scientists of our time. Can we afford the policy of banishing or banning great scientists in the face of our present perils? One recalls the remark of Lagrange to Delambre the day after the execution of Lavoisier: "Only a moment to cut off that head and a hundred years may not give us another like it." Therefore, it is imperative that we find the best balance of technological secrecy as weighed against free information—a balance designed to give us optimum strength. I will try to enumerate the factors involved.

1) The system of technological secrecy must not involve large undertakings. In a democratic system, it is absolutely impossible to cloak large undertakings in secrecy. Their very existence can be seen and discloses their main purposes. Large numbers of men—janitors, factory workers, engineers, scientists, and managers—know essential details. As I once remarked elsewhere, "It is like trying to hide an elephant under a paper hat." Since leaks inevitably occur for reasons beyond anyone's control, the enemy is informed, but our own scientists on the whole are not. Consequently, enemy progress on such undertakings is very possibly greater than our own. Penetration of a large scale project by a determined enemy is impossible to prevent by any known method except perhaps an Iron Curtain around the whole country.

2) The number of secret projects should be sharply limited. A widespread system with leaks is not rigidly respected. Therefore, the security value of those few projects that should be highly protected is devalued since they are jumbled together with thousands of projects that should never be classified at all. Consequently, the widespread secrecy system defeats the essential security. Real secrecy on a few critically important technological matters should be enforced rigidly and at every step. Only a few small critical projects can be policed with the rigidity that insures real hope of success. Technological secrecy should never be used where there is doubt that

its effectiveness can be complete, and should only be used in defined situations when there is complete confidence that it will be effective.

3) Technological secrecy is lost with the passage of time. Unlike tactical secrets of the battlefield that terminate with the battle, technological secrecy on a weapons project or idea has no natural terminal date. All technological secrets deteriorate with time, and they should be arbitrarily declassified after a year or two so that the technological advantage can continue to accrue from greater progress.

4) Basic scientific and engineering information should not be classified or restricted at all. The information that can be used for military purposes is so vast that it cannot be protected. Attempts to do so stop the flow of information on which progress depends. Here I am reminded of the case of the military scientist who was scheduled to present a paper before an important scientific meeting abroad on a subject that had been declassified. Although the paper was in print and was to appear 30 days later, he received a cable as he was about to read it, forbidding its presentation. The reaction of the high-level scientists abroad was certainly not suited to the enhancement of American scientific prestige. Often American scientists find subjects classified that are common knowledge abroad. Not infrequently, discoveries made under classified projects here are later published as original discoveries by foreign scientists.

5) The number of persons requiring clearance should be very small. This is the very essence of a good secrecy system. Moreover, the remaining bulk of individuals are then free to discuss, exchange, and utilize scientific information completely and without restraint. The regulations necessary to the maintenance of secrecy over large areas of technological information condition the scientist to miss the conception of militarily valuable ideas. Although responsible men resist such conditioning, the resulting frustrations inevitably reduce his creative effectiveness. Moreover, excessive security of information prevents some of the world's most creative men from contributing to our national welfare.

6) The security of progress should be the prime objective. We must not assume that what is good for the Soviet Government is good for us, though even the Soviet leaders sometimes find too much secrecy has disadvantages. I note in the New York *Times* for 27 February 1956 that during the 20th Congress of the Communist party "The attack on undue secrecy in scientific work was launched by Anastas I. Mikoyan, a First Deputy Premier, and carried a step further by Premier Nikolai A. Bulganin who accused many incompetent scholars of using it to conceal their failures."

The great forte of our democracy is the ability of free enterprise to adopt the best of all alternatives. We should provide freedom of knowledge for these alternatives to develop so that the choice is ours.

7) Widespread security of technological information is inimical to the security of progress. The security of progress provides well-developed weapons and men trained to use them effectively. In the absence of an Iron Curtain, security of information must depend on compartmentalization of knowledge. Very little compartmentalization is needed to destroy scientific progress or to restrict training and limit tactical familiarity with new weapons. Therefore, if we are to have security based on progress, the information to be restricted must be sharply delimited. If, eventually, we should have to fight, we must decide now whether it is to be with effective weapons about which an enemy knows a great deal, or with pieces of paper about which he knows nothing.

8) The secrecy of technological information is incompatible with the public policy function of a democracy. In our elective system, in the absence of public debate, there is no certainty that policy-making officials will possess the competence required for wise decisions or that they will even understand what elements of information are important. Moreover, even assuming the wisdom of policy-making officials, sound policy results from the careful examination of facts by the people of a nation in light of their diverse training and interests. Secrecy prevents the discussion necessary to such examination, and compartmentalization prevents proper evaluation even by trained specialists. The press and other public media are the sources of the background intelligence that most influences our policy-makers and military leaders. No adequate substitute can be found in internal intelligence because information unevaluated by public debate lacks the convincing quality that results from public review.

9) Widespread secrecy of technological information keeps the public ignorant of the adjustments it must make in the face of technological change. Failure to make adjustments to an evolving environment has in the past led to the extinction of a species. Yet the desire to make such adjustments can emerge in the human species only from a sound understanding of the alternatives as they become clear from public debate, or from the ultimate disaster into which society blunders.

10) Widespread technological secrecy with respect to national capabilities may lead the enemy to underestimate our power and encourage him in irresponsible adventures leading to war. There are many examples of this, although none can be proved absolutely, for events never conjoin in the same way in history.

Conclusions

A deep and searching inquiry into the restrictions on technological information is needed to determine where the public interest really lies. Such an inquiry would stand as a major milestone in our development of public policy and our social maturity. It would dispel the blind faith that more and more "secrecy" can somehow save us. It would define the kinds of technological information that should be kept secret and outline procedures for its selection and protection. It would require the exercise of judgment in balancing all of the factors required by the national interest and security in deciding when information should be classified. It would provide for periodic review of classified information and its quick release when appropriate.

We can no longer assume that restrictions on information that insulate the community from vital technological progress are a good thing. We must be hard-headed when we ask: Just what has secrecy brought us? Does the record show that it has provided protection, or is this just a myth? Just where are we stronger because the enemy has been kept in the dark? Or where are we weaker because he does not know our power? Where, because of lack of official understanding as a result of secrecy, has our government failed to press a technological development that would have strengthened us? To what extent are we failing to meet the great challenges of modern technology because inaction is hidden by the restrictions on technological information? Are we losing significant contributions to our safety and welfare that science could make? What secrets can be kept? How can society meet the social implications of a development if it does not have the chance to understand these implications?

And above all, what effect are these restrictions having on our democratic institutions and on our system of free enterprise? Are we permitting secrecy to cover the rise of systems under the absolute bureaucratic control of government beyond which no regulatory appeal can be made? And finally, the jackpot question: Is it true that with the aid of technological secrecy we are maintaining our lead and forging ahead of the enemy? Or is it possible that because of it we are falling behind?

D. R. Charles, Geneticist and Statistician

Selfless men like Donald Charles rarely leave their record of achievement in a form that may be properly assessed, or even understood, by most of those who survive them. Don Charles' personal writings probably number less than twenty. Even though they include an exemplary summary of statistics for students of genetics and widely known studies of crossing over, the developmental genetics of mice, and the genetic effects of radiation, his scholarship is not to be read from these alone. Nor is it to be judged from the nine manuscripts that remained in his files.

Master of statistics and functional biology, especially of genetics, his help and insight were constantly sought by students and peers alike. Since he was without personal interest in credit or recognition, he freely contributed his very best to all, and most of his original thought and productivity were dissipated usefully, but quite anonymously, through numberless publications of others. He made his mark in the minds and affections of those he helped, and through them he will continue to be heard.

Don Charles graduated from Franklin and Marshall College (1928), studied 2 years at the University of Pittsburgh, and then completed his graduate work in the department of zoology at Columbia University (1930–35). At Columbia he was profoundly influenced, in a manner that colored all his later thoughts and actions, by L. C. Dunn, Selig Hecht, and Donald Lancefield. His doctoral thesis on a causal analysis of spotting patterns in mice was carried out under Dunn's sponsorship. Then Don Charles enjoyed a golden year of study, of which he often spoke, with Sewall Wright at Chicago as a National Research Council fellow (1935–36).

Following an instructorial year at Sarah Lawrence College, Don Charles joined the staff of the department of biology at the University of Rochester (1937), rising to professor and chairman of the department (1948–53). During World War II (1943–46), he was geneticist of the Manhattan Engineering District at the University of Rochester, planning and directing the radiation studies on mice that played so important a role in the estimation of permissible radiation doses. In 1947 he served on the National Committee on Radiation Protection and on the Committee on Applied Mathematical Statistics (National Research Council).

At Rochester, Don Charles taught, at one time or another, general biology, comparative anatomy, statistics, human genetics, general genetics, and a series of graduate seminars that ranged through mathematical genetics, evolution, and immunology. His lectures and beautifully conceived laboratory exercises were notable for their originality, insight, and constructive synthesis, no less than for their success as educational experiments. Although his demands on the imagination, work habits, and participation of the students at all levels were exceptional and his grading was vigorous, the students caught his enthusiasm, and many first discovered the inner rewards of scholarship and understanding in these courses. To all students he was an outgoing, good-humored friend, and his very personal relationships with them went far beyond his academic duties. He fulfilled their needs wherever he could, giving freely his instruction, counsel, friendship, books, and —to the needy—his money. Quite characteristically, when in war service, as a geneticist, he firmly but quietly refused any increase in salary on the grounds that the combat soldier was not similarly privileged. To the regret of his friends, the encompassing altruism he practiced was one way only; he offered little opportunity for any to give back, and he asked nothing on his own behalf.

When he learned, in 1950, that his physical distress was caused by Hodgkin's lymphoma, he began a methodic retrenchment within himself, although he continued to fulfill his academic and scientific obligations to the utmost. Systematically, and at an ever increasing rate, Don Charles narrowed his wide circle of friends as the disease advanced. In the summer of 1954 he resigned from the university, even though most extraordinary steps were taken to retain him. Thereafter, he acted as a mathematical consultant to the Haloid Corporation, an organization for which he had earlier done a good deal of mathematical work.

By the fall of 1955, Don Charles was a companion to few. Early in November he evidently sensed the onset of the terminal stages of the lymphoma and quietly disappeared from his job and from Rochester. Having paid a final visit to his birthplace, Bethlehem, Pennsylvania, he died alone, in New York City, on Thanksgiving morning, at the age of 46. His body was brought to Rochester and it was interred by the Haloid Corporation and the University of Rochester, the two institutions to which Don Charles had devoted the most productive years of his professional life.

Don Charles probably never admitted to himself, or even recognized, the affection and devotion in which he was held by people in all walks of life nor the magnitude of his scholarly accomplishments. As with very many others, I am proud to have been among his "students" and to have had his thought reflected in my work; we are all better scientists because of him.

K. W. Cooper
University of Rochester, New York

The guarantee of science is in the verification of experience, direct or indirect. It distrusts the validity of a priori conclusions, or of any explanation drawn solely from general ideas of Nature's order, unless those general ideas have themselves been rigorously demonstrated to be necessities of thought, or to represent the observed order. What must be, or may be, has to give place to what is. The general doctrines of Science are never, like those of Theology and Metaphysics, conceived to be final.—George Henry Lewes, Aristotle: a Chapter from the History of Science (*Smith, Elder and Co., London, 1864*).

News of Science

IGY Whistler Observations

An informal meeting on whistlers and related audiofrequency wave phenomena was held at the Central Radio Propagation Laboratory of the National Bureau of Standards in Boulder, Colo., 14–16 Feb. The purpose was to discuss recent progress in this new field of research and to develop further the plans for the North American program of synoptic observations during the International Geophysical Year (1957–58).

The United States synoptic program will be under the joint direction of M. G. Morgan of Dartmouth College and R. A. Helliwell of Stanford University, chairman and member, respectively, of the Technical Panel on Ionospheric Physics, which is advisory to the U.S. National Committee for the IGY. These two men will be assisted by H. W. Curtis of Dartmouth, Harold Dinger of the Naval Research Laboratory, and A. Glenn Jean of the Central Radio Propagation Laboratory, who are consultants to the panel. The Canadian work in this field is under the direction of L. R. O. Storey of the Defense Research Board of Canada.

Whistlers are a special kind of natural radio signal in the audiofrequency range. They are believed to be caused principally by energy from lightning discharges that has traveled from one hemisphere to the other along lines of the earth's magnetic field in the little-explored longitudinal extraordinary mode of propagation. During propagation through the ionosphere, the energy from the causative lightning impulse is dispersed in such a way that the high frequencies usually (but not always) arrive ahead of the low frequencies and a signal of descending frequency is produced.

The reason for the considerable effort to be put forth in the study of these audiofrequency wave phenomena is twofold. First, they offer a new method for detecting the presence of ionization far beyond the reaches of the known ionosphere. This is because the paths of whistlers extend several earth radii above the earth's surface. Second, although the origins of certain related phenomena, such as the dawn chorus and hiss, are not yet known, they have been observed to be connected in some way with auroral and magnetic disturbance phenomena. Understanding in these areas, therefore, offers a potentially powerful new tool for the study of the mechanisms of aurorae and magnetic storms.

The main objective of the IGY synoptic program is the determination of the occurrence and characteristics of whistlers and related phenomena at regular intervals and at many locations on the earth's surface. Magnetic tape recordings will be made at each station during the observing periods. All useful data will be given a preliminary classification and preserved for later detailed analysis.

An important recent addition to the experimental program is the inclusion of direction-finding on atmospherics for the purpose of determining the geographic location of impulses that cause whistlers. Such information is required because very little is known about the effect of the location of the impulse on the measured characteristics of the resulting whistler.

An extensive discussion at the Boulder meeting of the requirements of recording equipment led to the following tentative specifications. Each station should be capable of recording on magnetic tape the amplitudes of all signals in the frequency range between 100 cycles and 30 kilocycles. The calibration should be given in terms of the electric or magnetic field components measured by the antenna.

Events on the magnetic tape should be timed to an accuracy of at least, ± 0.1 seconds. Each recording period should be not less than 2 minutes in length and should be repeated no less than once every hour. Special runs during World Days, periods of magnetic disturbance, rocket firings, and so forth, will be scheduled in accordance with the needs of the program.

A tentative list of stations contributing to the North American program on whistlers was developed. For convenience, these were divided into an Atlantic group, a Midcontinent group, and a Pacific group. The stations indicated as tentative are either above or below the geomagnetic latitude range 40°–65° in which maximum activity occurs. Stations marked with an asterisk are currently in operation.

Atlantic group: Thule, Greenland (tentative); Frobisher Bay, Northwest Territories (tentative); Knob Lake, Quebec*; Father Point, Quebec; Ottawa, Ontario; Halifax, Nova Scotia; Hanover, N.H.*; Washington, D.C.*; South Carolina; Bermuda*; Gainesville, Fla.*; Key West, Fla. (tentative); Huancayo, Peru (tentative), or Talara, or Trujillo; Falkland Islands (by cooperation of the United Kingdom); Port Lockroy, Antarctica (by cooperation of the United Kingdom).

Mid-continent group: Flinflon, Manitoba; Boulder, Colo.*; Battle Creek, Mich.

Pacific group: Fairbanks, Alaska*; Nome, Alaska; Anchorage, Alaska; Unalaska, Alaska*; Seattle, Wash.*; Stanford, Calif.*; Wellington, New Zealand (by cooperation of New Zealand)*; Dunedin, New Zealand (by cooperation of New Zealand)*; Macquarie Island (by cooperation of Australia).

In order to accelerate current research and obtain experience for the IGY program, it was agreed to commence at once an exchange of summaries of data between operating whistler laboratories.

R. A. HELLIWELL

Stanford University, Stanford, California

M. G. MORGAN

Dartmouth College, Hanover, New Hampshire

International Atomic Energy Agency

A charter for the international atomic energy agency was approved on 18 Apr. after 2 months of negotiation by the 12 nations that were selected to frame the draft: Australia, Belgium, Brazil, Canada, Czechoslovakia, France, India, Portugal, the Union of South Africa, the Soviet Union, the United Kingdom, and the United States. At the same time plans were approved for an international conference next September at United Nations headquarters, when the charter will be submitted for ratification by the member nations.

The U.S. State Department issued n announcement of the outcome of the 12-power talks, but the text of the statute was not immediately made public. However, it has been reported that the agency will have a 23-man board of governors. Of these, five will represent the countries "most advanced" in nuclear technology—that is, the United States, the Soviet Union, Great Britain, France, and Canada.

Five other board members will be chosen from among eight regional

groups. The first members in this category are expected to be Brazil, South Africa, India, Australia, and Japan. There will be one country, probably Sweden, to represent nations that have technical knowledge but no uranium supplies.

Two seats will go to nations with large supplies of raw materials. These seats are expected to alternate between Belgium and Czechoslovakia one year and Poland and Portugal the next year.

Ten other members of the board of governors will be elected by the annual meeting of the agency's general conference, which will be composed of all members of the agency. These ten seats will be for underdeveloped countries that will benefit from the aid program.

Under this program, major atomic powers will contribute fissionable materials for the agency to allocate for peaceful uses in underdeveloped countries. Each country receiving such gifts will have to submit to inspection by representatives of the agency. The United States, the Soviet Union, and other countries that have a surplus of uranium would not face inspection, for the provision applies only to countries receiving aid. However, a recipient country will have the right to veto inspection by the nationals of an individual country.

The new plan for the agency, first proposed by President Eisenhower in a speech before the United Nations in December 1953, represents a major compromise. The United States and seven of its Western allies completed the first draft of the plan nearly a year ago, but it proved so controversial that no agreement could be reached. Then India suggested the 12-nation conference to review the original document.

The relationship of the agency to the United Nations was one of the most difficult problems to settle. The United States urged that it have the status of a specialized agency, like the World Health Organization, and report only to the Economic and Social Council. India felt that it should have a closer connection to the U.N., and the Soviet Union wanted it to come under the jurisdiction of the Security Council, where it would be subject to the veto power. The present agreement takes a middle course under which the agency will report primarily to the General Assembly.

Nevertheless, the September conference is expected to bring some conflicts. The Soviet Union has reserved the right to propose at that time the admission of the People's Republic of China and its appointment to the agency's board of governors. India also has objections to some of the language on inspection procedures and to the composition of the board of governors.

When these and other difficulties are overcome and the draft statute is endorsed by the 84 countries belonging to the United Nations or its specialized agencies, it must then be ratified by the parliaments of at least 18 countries, the minimum required to bring the statute into force. It is believed that this can be accomplished by June 1957.

Sea-Water Distillation

One of the largest sea-water evaporating and distilling plants ever to be built has been ordered from a firm in Glasgow, Scotland, for installation at the Netherlands Antilles island of Aruba in the Caribbean. The unit is capable of providing 8000 tons of fresh water daily. There is practically no rainfall on Aruba or any other source of fresh water. During the course of 30 years a number of smaller sea-distillation plants have been installed there, each with an output of 300 tons of fresh water a day, but increasing local demands now call for a much greater supply.

The new plant will be completed in 1958. It will comprise four horizontal evaporating units, each with it own interstage preheaters, distilling condenser, and pumps. Each unit will have a daily output of 2000 tons of fresh water. Steam, bled from turbines of the electric power generating station, will be supplied to the heating coils of the first stage of each evaporator unit.

Survey of Chemists

A comprehensive report on the economic status of the chemical profession was made public on 9 Apr. as the American Chemical Society opened its 129th national meeting in Dallas, Tex. The survey was conducted last year by Andrew Fraser of Washington, D.C., consultant, for the ACS Committee on Professional Relations and Status, of which Herman S. Bloch of Universal Oil Products, Des Plaines, Ill., is chairman. The study took the form of a questionnaire mailed to 64,606 ACS members residing in the continental United States. (The society's total membership at present is 76,522.)

Usable returns were received from 45,432 members, or 70.3 percent of the mailing list. Of the respondents, 95 percent were men and 5 percent women, most of the latter being chemists. Among the men, 63 percent were chemists, 21 percent chemical engineers, and the other 16 percent, although basically trained as chemists or chemical engineers, were in classifications designated as "other field of science or engineering" (8 percent) and "any other field" (8 percent). The Fraser report was published in full in the 9 Apr. issue of *Chemical and Engineering News*.

A comparison of 1955 earnings with those reported in two earlier ACS surveys, made in 1941 and 1943, shows a considerable rise since the war years. In 1941, base salary for beginning chemists was $132 a month at the median. By 1955, the median salary of beginners was up to $435, a 230 percent rise. For more experienced chemists the percentage increase, although not so great, was still appreciable—at the 20-year level of experience it was about 125 percent, from a median of $339 in 1941 to $763 in 1955.

When median salaries for both years were placed on a constant dollar basis by adjustment to the Bureau of Labor Statistics consumer price index, it was found that men chemists starting out in 1941 earned $209 a month, and those starting in 1955 earned $380. On the same basis, chemists with 20 years of experience drew $539 in 1941 and $666 in 1955. These figures represent income before taxes, and the report does not take into account the effect upon net income of the changes in tax structure since the war.

Changes in work patterns also appear to have been a factor in upgrading earning levels between 1941 and 1955. Last year about 20 percent of all ACS members were engaged in technical administration—a relatively high-paying field of work—compared with 15 percent in 1941. On the other hand, the proportion of members in some relatively low-paying fields declined. There were decreases, for example, from 13 to 8 percent in analysis and testing, and from 12 percent to 9 percent in college teaching.

Significant changes in sources of employment also were disclosed. In 1941 18 percent of the society's members were employed by government agencies—Federal, state, and municipal—and only 8 percent were so employed last year. In the same period, industrial employment rose from 64 to 69 percent, and jobs in teaching institutions held steady at about 12 percent. There was a sharp decline in the percentage of men chemists (19 percent to 8 percent) and chemical engineers (7 percent to 4 percent) in government work, largely the result of even sharper dips in state and municipal employment. About 13 percent of women chemists hold government jobs, compared with 18 percent in 1941, while 45 percent now work for industry—a relatively large increase over the 27-percent figure that obtained in 1941.

Of the ACS members participating in the survey, 42 percent hold doctorates, another 19 percent have the master's degree, and only 3 percent have no college degree. Chemical engineers appear to have a lesser tendency to pursue

graduate study. Only 12 percent have the doctor's degree, and 62 percent stopped at the bachelor's level. Among women chemists, 26 percent have doctorates and 50 percent have no advanced degree.

Chemical engineers as a group seem to have an earnings advantage over chemists, the report indicates, but when chemists and chemical engineers hold comparable jobs they tend to receive about the same salaries. The report also showed that men chemists, throughout their careers, earn about 1½ times as much as women chemists.

Among the occupations most common among chemists and chemical engineers, the best paying is technical administration, with a median salary (disregarding experience and education) of $856 monthly for chemists and $898 for chemical engineers. Industrial research comes next—$638 for chemists and $647 for engineers. Lowest median salaries for the more prevalent occupational categories are found in college and university teaching ($517 for chemists and $637 for chemical engineers) and in analysis and testing ($473 for chemists and $520 for engineers). Of all occupations reported, secondary-school teaching paid least, with a median salary for chemists of $443 a month. The best-paid jobs, outside technical administration, were in nontechnical administration consulting and in law.

Search for Cancer Drugs

The U.S. Public Health Service has placed contracts with five laboratories for large-scale screening of chemical compounds in the search for drugs useful in treating cancer. The laboratories, which will begin the work at once, are Microbiological Associates, Bethesda, Md.; Wisconsin Alumni Research Foundation, Madison, Wis.; Southern Research Institute, Birmingham, Ala.; Hazleton Laboratories, Falls Church, Va.; and Stanford Research Institute, Menlo Park, Calif. Responsibility for supervising the contracts rests with the Cancer Chemotherapy National Service Center of the National Cancer Institute.

The laboratories are expected to examine approximately 2000 compounds by 1 July. Each compound will be tested against three different kinds of cancer implanted into various strains of mice under procedures for animal screening established by a panel of the Cancer Chemotherapy National Committee. This committee, representing the leading organizations and Government agencies in cancer research, was established last May to sponsor a national voluntary program of cooperative research and development in cancer chemotherapy.

State Conservation Programs

A survey of how each state is organized to give educational leadership in conservation and use of resources is being conducted under the direction of Richard L. Weaver, associate professor of conservation in the School of Natural Resources at the University of Michigan. The work is supported by a grant from the Horace H. Rackham School of Graduate Studies. Each state agency concerned with education about resources is being asked to complete an inventory statement covering such matters as leadership, state committees, program, financing, publications, cooperation, legislation, and problems or obstacles to progress.

The results of the inventory will be used by Weaver in scheduling visits to each of the states to interview the people responsible for the programs. It is expected that the results of the study will help professional organizations and foundations in their efforts to be of greater service nationally.

Code for Atomic Structure of Solids

A new code for describing the atomic structure of solids has been invented by A. L. G. Rees, assistant chief of the Division of Industrial Chemistry, at the Australian Commonwealth Scientific and Industrial Research Organisation. Rees described his new system of symbols on 5 Apr. at the Symposium on Crystallography that was held in Madrid, Spain. He pressed for universal adoption of the code, saying that it will enable scientists to set out their research results without ambiguity, which should lead to more rapid advances in many aspects of industrial research.

The code makes it possible to describe concisely the irregularities in the atomic structure of crystalline solids. These irregularities are of special industrial importance. They are important in photography, fluorescent lamps, TV screens, luminous watch dials, and transistors. They play an important part, too, in many processes of modern chemistry and metallurgy; for example, the catalysts that are used in the cracking of crude oil to produce gasoline depend on them for their activity.

News Briefs

■ A new laboratory animal, *Meriones libycus,* is being introduced into this country from England, where it has been bred for the past several years for use in studies on the Coxsackie virus. The animal is a species of desert rat found in Libya and North Africa that was originally imported into England in November 1951 by the late G. M. Findlay. He had obtained two pairs from Lapine of the Pasteur Institute in Paris.

■ The Library of Congress has agreed to prepare a continuing, annotated bibliography on air pollution for the U.S. Public Health Service. The bibliography will include references to the physical, biological, engineering, legal-administrative, and economic aspects of atmospheric pollution.

Last year, the Congress appropriated $1,785,000 for Public Health Service support of air-pollution research and technical assistance. In December it was announced that the Bureau of Mines, the National Bureau of Standards, and the Weather Bureau, would undertake research projects in air pollution for USPHS.

■ The Geological Survey has developed a new orthophotoscope that was displayed publicly for the first time at the recent annual meetings in Washington of the American Congress on Surveying and Mapping and the American Society of Photogrammetry. The device changes conventional aerial photographs, with all their distortions from camera tilt and changes in elevation on the ground, into the equivalent of distortion-free photographs. It produces a corrected photograph that is a true map or photomap of uniform scale. This development makes it possible for the first time to measure straight-line distances accurately on an aerial photograph.

■ Assistance in establishing a nuclear physics department at the Federal University of Karachi will be provided to the Government of Pakistan by the United Nations Educational, Scientific and Cultural Organization. Frans Barendregt, chief scientist at the new Dutch Nuclear Reactor Center at The Hague, is being sent to Karachi for this purpose. He is the first nuclear scientist to go on a mission under the UNESCO program designed to serve countries in fields not covered by the United Nations technical assistance program.

■ An albacore tuna tagged 1300 miles north of Hawaii on 5 Oct. 1954 by the U.S. Fish and Wildlife Service was recaptured near Japan, 2370 miles away, 471 days later. It weighed 15 pounds when it was tagged and 40 pounds when it was recaptured.

It is thought that the albacore tuna of the North Pacific may belong to a single population that migrates between the United States and Japan. However, this is only the second time that an albacore tagged by the U.S. has been taken

in Japanese waters. The first time was about 3 years ago when an albacore tagged off the California coast was taken near Tokyo. The tuna migration study is one of many being conducted by the Pacific Oceanic Fishery Investigation unit of the Fish and Wildlife Service.

Scientists in the News

LEONARD A. SCHEELE, Surgeon General of the U.S. Public Health Service, Department of Health, Education, and Welfare, took the oath of office for his third term, on 16 Apr.

MASANORI NAKAIDZUMI, who recently retired as professor of radiology at Toyko University, has been appointed associate director of the Atomic Bomb Casualty Commission, a field agency in Japan that is operated by the U.S. National Academy of Sciences–National Research Council and supported by the U.S. Atomic Energy Commission. The Atomic Bomb Casualty Commission was established to aid the survivors of the nuclear explosions that took place in Hiroshima and Nagasaki. The health studies being conducted by the commission will be continued as long as there remains any possibility that new knowledge may be obtained from them.

J. ROBERT OPPENHEIMER, director of the Institute of Advanced Studies, and DWIGHT H. MURRAY, president-elect of the American Medical Association, have received the first Dignity of Man awards from the Kessler Institute for Rehabilitation, West Orange, N.J. The awards were made on 11 Apr. at a dinner for Henry H. Kessler, founder of the institute, on his 60th birthday. Oppenheimer and Murray were selected for the first presentations in recognition of their "significant achievements and pioneering efforts on behalf of the dignity of man through their respective professions."

COURTLAND D. PERKINS, chairman of the department of aeronautical engineering at Princeton University, will replace H. GUYFORD STEVER as chief scientist of the U.S. Air Force. Perkins will be on leave from the university faculty while he holds the Air Force post.

The following awards were presented on 9 Apr. during the 129th national meeting of the American Chemical Society in Dallas, Tex.

WILLARD F. LIBBY of the U.S. Atomic Energy Commission received the ACS award for nuclear applications in chemistry, sponsored by the Nuclear Instrument and Chemical Corporation, ". . . for a succession of bold and original researches in sensitive instrumentation, natural radioactivity, and the chemistry of energetic atoms, that opened new fields for nuclear chemistry."

PAUL M. DOTY, associate professor of chemistry at Harvard University, received the ACS award in pure chemistry, sponsored by Alpha Chi Sigma Fraternity ". . . for significant and fundamental contributions to our knowledge of the size and shape of macromolecules in dilute solutions."

HAROLD W. WASHBURN, vice president and director of research for the Consolidated Engineering Corporation, Pasadena, Calif., received the Beckman award in chemical instrumentation ". . . for his perseverance, inventiveness, and scientific leadership in developing mass spectrometry as a field of instrumentation, and for his efforts through publications, lectures, and personal contacts in advancing the widespread application of mass spectrometry in chemistry."

SAMUEL R. HOOVER, assistant chief of the U.S. Department of Agriculture's Eastern Utilization Research Branch, Philadelphia, Pa., received the Borden award in the chemistry of milk ". . . for his systematic studies relating the properties of casein to its chemical constitution, particularly with respect to the water-binding capacities of many of the individual groups in the casein molecule, which are of importance in understanding the behavior of milk proteins and in indicating the conditions of water uptake by dried milk products."

HARVEY C. DIEHL, professor of chemistry at Iowa State College, received the Fisher award in analytical chemistry ". . . for his development of inorganic and organic chelation reagents of analytical importance, studies of oxygen-carrying metallic organic compounds, advancements in automatically controlled electrodeposition procedures, and refinement of polarographic, electrochemical, solvent extraction, and tracer techniques."

HERMAN PINES, director of the Ipatieff High Pressure and Catalytic Laboratory at Northwestern University, received the Fritzsche award ". . . for significant achievements in the application of catalysis and high pressure in the terpene field. His work has led to methods of preparation, to new techniques for the determination of structures, and to new terpene reactions, resulting in a better understanding and correlation of the chemistry of these compounds."

ALLENE R. JEANES, chemist in the Northern Utilization Research Branch of the Agricultural Research Service, Peoria, Ill., received the Garvan medal ". . . for her pioneering research on the chemistry of dextran produced by numerous bacterial strains, for outstanding contributions in advancing fundamental knowledge of the chemistry of carbohydrate polymers, and for her zeal and leadership in an extensive research program on the development of dextran as a blood plasma extender for national defense."

HARRY G. DRICKAMER, professor of chemical engineering at the University of Illinois, received the Ipatieff prize ". . . for significant contributions to the knowledge of the fundamental properties of matter, and for his development of novel experimental techniques for the investigation of the behavior of solids, liquids, gases, and solutions under extremely high pressures."

VICTOR K. LA MER, professor of physical chemistry at Columbia University, received the Kendall Company award in colloid chemistry ". . . for his many contributions to the science of colloid chemistry, especially for the formulation of the theory of the formation of monodispersed hydrosols and for improvements in the theory of the production and use of aerosols for military and other purposes."

ROBERT A. ALBERTY, associate professor of chemistry at the University of Wisconsin, received the Eli Lilly and Company award in biological chemistry ". . . for his fundamental contributions to enzyme kinetics. His studies have yielded useful relationships between the kinetics of the forward and reverse reactions and for the determination of the ionization constants of essential groups in enzymes. With these constants he has proposed a consistent reaction mechanism to give a structural basis for the behavior of the catalyst fumarase."

MERTON F. UTTER, associate professor of biochemistry at Western Reserve University, received the Paul-Lewis Laboratories award in enzyme chemistry ". . . for his outstanding and fundamental contribution showing that the oxalacetate carboxylase reaction is a major reaction in animal tissue, that net fixation of carbon dioxide can occur by this reaction, that the nucleoside phosphate acceptor inosine diphosphate or guanosine diphosphate must be added to promote net fixation, that nucleosides other than ATP can participate in phosphate transfer reactions, that the oxalacetate carboxylase reaction provides a mechanism for synthesis of phosphopyruvate thereby clarifying the pathway of carbohydrate synthesis."

MILBURN J. O'NEAL, JR., of the Shell Oil Company, Houston, Tex., received the Precision Scientific Company award in petroleum chemistry ". . . for outstanding achievements in the knowledge of the composition of petroleum. By ingenious research he opened up the field of high temperature mass spectrometry, was able to obtain mass spectra

of high molecular weight hydrocarbons, and has developed methods for determination of hydrocarbon composition of petroleum fractions which have led to better understanding of petroleum processing."

CARL S. MARVEL, research professor in the Hayes Chemical Laboratories of the University of Illinois, received the Priestley medal, highest honor in American chemistry, ". . . for distinguished services to chemistry."

OTTO M. SMITH, director of the Research Foundation at Oklahoma Agricultural and Mechanical College, received the Scientific Apparatus Makers award in chemical education ". . . for his persistent efforts to improve methods of chemical instruction, organization of summer conferences for teachers, development of better testing programs, and otherwise focusing attention on the problems of chemical education. His accomplishments as educator and administrator confirm his belief in people and in chemistry."

JOHN E. IVEY, sociologist, educator, and director of the Southern Regional Education Board, Atlanta, Ga., has been granted a 6-month leave of absence to make a study-tour of European and Near and Far East countries under an Eisenhower fellowship. He will return in October.

The Eisenhower fellowships are awarded each year to two citizens of the United States and ten from other countries. The Americans may travel to any part of the world they choose, while the other awards are made for travel in the United States. No stipulations are made by the donors, who seek to provide recipients with the opportunity for "first-hand observation of developments in their fields" in all parts of the world.

ADOLPH MEYER-ABICH of the University of Hamburg (Germany) is a visiting professor this spring in the University of Texas zoology department. He has announced plans to give the university zoology library about 3000 volumes dealing with the history and philosophy of biological knowledge.

E. M. K. GEILING, Frank P. Hixon distinguished service professor of pharmacology at the University of Chicago, will receive the Oscar B. Hunter memorial award from the American Therapeutic Society on 9 June at the Sheraton-Blackstone Hotel in Chicago.

C. W. THORNTHWAITE, director of the Laboratory of Climatology, Drexel Institute of Technology, recently gave a series of lectures on climate and the modern world at the Wagner Free Institute of Science, Philadelphia, Pa.

JOSHUA LEDERBERG of the University of Wisconsin and his wife, Esther, have been selected as joint recipients of the 1956 Pasteur award of the Society of Illinois Bacteriologists. They are being honored "in recognition of their outstanding contributions to microbiology, particularly for their fundamental studies in bacterial genetics." The award, which is made annually to an outstanding Midwestern microbiologist, will be presented on 19 May.

With E. L. Tatum, Lederberg pioneered in studies of sexual recombination in bacteria. These investigators were the first to discover that individual bacteria could combine their genetic traits, and that combined traits were then transmitted to offspring.

After the announcement of this work in 1946, the Lederbergs continued research into the genetic mechanisms by which recombination is accomplished and found that bacteria join in a sexual process. In more recent work, they have learned that fragments of genetic material can be transferred from one cell to another, and that bacterial viruses are themselves hereditary factors and in some forms cannot be differentiated from genes.

WILLIAM B. BEAN, head of the department of internal medicine at the State University of Iowa, gave a Mayo lecture at the Mayo Clinic, Rochester, Minn., on 30 Mar.

ALLEN H. SCHOOLEY, superintendent of the electronics division of the Naval Research Laboratory in Washington, D.C., is in Rio de Janeiro, Brazil, where he will assist the Brazilian Navy in the establishment of a naval research laboratory. During his year's leave of absence he will participate in the initial planning of the laboratory, the procuring of equipment, and in the planning of the first research problems.

WALTER R. J. BROWN, research physicist in the Kodak Research Laboratories, Rochester, N.Y., has received the Adolph Lomb medal of the Optical Society of America. The award is given every second year to a person under 30 who has made a "noteworthy contribution to optics."

JOHN W. GRAHAM, JR., civil engineer and dean of students at Carnegie Institute of Technology, has been appointed vice president of the Cooper Union for the Advancement of Science and Art. When Graham takes office on July 1 he will become the school's first vice president. The post was created recently by the trustees because of an extensive development program that includes a new engineering school building.

WALTER B. SHELLEY, associate professor of dermatology at the University of Pennsylvania, will receive the $1000 special award of the Society of Cosmetic Chemists this month for his research on apocrine and exocrine sweat glands.

WILLIAM SEEMAN, formerly chief of the clinical psychology department at the Mayo Clinic, has been appointed associate professor of medical psychology at the University of Oklahoma School of Medicine.

M. V. NEVITT, former head of the metallurgical engineering department at Virginia Polytechnic Institute, has resigned to join the staff of Argonne National Laboratory.

GEORGE W. HOWARD, chief of the technical service department of the Engineer Research and Development Laboratories at Fort Belvoir, Va., has been promoted to fill the newly created position of technical director of the laboratories.

GERALD L. THORNE, senior nematologist for the U.S. Department of Agriculture, where he has been employed since 1918, will retire this summer. He will join the University of Wisconsin on a half-time basis on 1 July, where he will have a joint appointment in the departments of plant pathology and zoology.

Another appointment at Wisconsin is that of JOHN E. MITCHELL, plant pathologist at Camp Detrick, Md., who has been named associate professor of plant pathology.

AMEDEO S. MARRAZZI, former assistant director (for neurological sciences) of the Chemical Warfare Laboratories' Directorate of Medical Research, has become the director of the Veterans Administration Research Laboratories in Neuropsychiatry, which he is organizing, and research director of the Veterans Administration Hospital at Leech Farm Road, Pittsburgh, Pa., where the new neuropsychiatric laboratories are located.

HAROLD B. RICHMOND, board chairman, General Radio Company, has received the Scientific Apparatus Makers award "in recognition of his leadership, vision and devotion to the growth and progress of the scientific instrument industry."

BERNARD J. JANDORF has been appointed chief of the biochemical research division in the Directorate of Research, Chemical Warfare Laboratories, Army Chemical Center, Md. He will continue to hold his previous post of chief of the enzyme chemistry branch, which forms a part of the division.

MACK DRAKE, research professor of chemistry at the University of Massachusetts, received a bronze medal and a $500 award during the recent annual meeting of the New York Farmers, an association of industrialists and professional men who own farms and are actively interested in conservation and agricultural research. He was honored for his findings that help explain the differences in the ability of plant species to absorb fertilizer elements from the soil.

MORRIS T. JONES, biological science representative of the Office of Naval Research in Chicago, Ill., has joined the staff of the National Institutes of Health as assistant to the chief of extramural programs, National Institute of Allergy and Infectious Diseases.

JOHN W. A. BRANT, formerly a member of the staffs of the universities of Connecticut and Illinois, and now a professor on the faculty of agricultural and veterinary sciences at the University of Guayaquil, has been elected by unanimous vote of the council of the university as *profesor honorario* in consideration of his assistance to the university in promoting application of the biosciences to agriculture.

CHARLES K. LEITH, a member of the Combined Development Agency, received a citation from the U.S. Atomic Energy Commission for outstanding services when he retired on 17 Apr. The Combined Development Agency is a joint United Kingdom–United States–Canadian organization established in Washington in 1944 to develop the production and to undertake the procurement of uranium and thorium supplies in certain areas. The agency has production contracts with the Belgian Congo, the Union of South Africa, Australia, and Portugal.

Leith has been one of the three U.S. representatives on the agency since its establishment. A geologist, he has been a faculty member of the University of Wisconsin since 1902, and at present is professor emeritus in the university's department of geology.

Recent Deaths

VERNON B. BAGNALL, Glen Ridge, N.J.; 50; communications authority who organized the plans for the distant early warning line that is being built at the Arctic Circle; 10 Apr.

DONALD CARLISLE, Poughkeepsie, N.Y.; 61; advertising executive; nature writer; vice president of the New York Zoological Society; 5 Apr.

FRANK J. GLUECK, Philadelphia, Pa.; 68; mechanical engineer associated with the R. M. Luff Company; 9 Apr.

WILLIAM C. HAINES, St. Louis, Mo.; 69; retired assistant meteorologist at the St. Louis Weather Bureau who had accompanied Richard Byrd on three polar expeditions; 7 Apr.

HERBERT B. HARROP, Middlebush, N.J.; 80; retired chemical engineer; 8 Apr.

STERLING HAYWARD, Yonkers, N.Y.; 83; retired mechanical engineer; 6 Apr.

JAMES L. HOWE, Lexington, Va.; 96; professor emeritus of chemistry and university historian at Washington and Lee University; secretary of AAAS Section C in 1892 and vice president of the section, 1900; 20 Dec.

SIGMUND KOPALD, Los Angeles, Calif.; 81; retired professor of pharmacy at Fordham College of Pharmacy; 5 Apr.

GEORGE M. LANDAU, Chicago, Ill.; 64; assistant professor of radiology at Northwestern University; 10 Apr.

FREDERICK H. LEONHARDT, Douglaston, N.Y.; 83; industrial chemist; 10 Apr.

CHARLES C. LIEB, New York, N.Y.; 76; Hosack professor emeritus of pharmacology at Columbia University; 6 Apr.

ALFRED LEIMDORFER, Chicago, Ill.; 67; professor of pharmacology at Stritch School of Medicine, Loyola University; 9 Apr.

ROY F. MILDRUM, Hillside, N.J.; 61; senior project engineer for the Esso Engineering Division of the Esso Research and Engineering Company; 7 Apr.

PERCY P. PRATT, White Plains, N.Y.; 59; special projects engineer for the General Foods Corporation; 4 Apr.

Education

■ The U.S. Atomic Energy Commission has announced that on 16 Apr. 62 students, 47 from 23 foreign nations and 15 from the United States, began the third session of the School of Nuclear Science and Engineering, which is operated for the AEC by the Argonne National Laboratory. Arrangements were made with Pennsylvania State University and North Carolina State College, which have research reactors, for the students to take the first part of the 10-month course on the campuses of these two institutions. The previous session of the school will end in June. When the third group finishes its basic training, it will transfer to the Argonne National Laboratory for advanced study.

Most of the U.S. enrollees are sponsored by American industry. Financial support for many of the foreign students in the program is provided through the International Cooperation Administration and the State Department. Among the foreign students, the following nations are represented for the first time: Ceylon, Denmark, Finland, Korea, Venezuela, and Yugoslavia.

■ The University of Buffalo has announced the establishment of a department of anthropology and linguistics, effective 1 July. Henry L. Smith, Jr., will be chairman of the department, and professor of linguistics and English; George L. Trager has been appointed professor of anthropology and linguistics, and will also serve as chairman of the department of modern languages and literatures; and Raymond L. Birdwhistell will be associate professor of anthropology.

■ A new joint professorship of religion and health has been established in the School of Medicine and the Federated Theological Faculty of the University of Chicago. The Rev. Granger Westberg has been appointed to the post, effective 1 June.

■ Pratt Institute, Brooklyn, N.Y., will initiate a graduate program in engineering in September. Courses will be given in the evening, but they will be administered by the engineering faculty of the undergraduate day school.

Grants, Fellowships, and Awards

■ The Paul Schwarzkopf Foundation for the training of Austrian powder metallurgists in Austria and the United States has been established. The foundation was set up by the Metallwerk Plansee, Reutte, Austria, with a grant of 500,000 Austrian shillings (about $19,500) in honor of Schwarzkopf's 70th birthday on 13 Apr. Schwarzkopf, who owns the Metallwerk Plansee, is president of the Schwarzkopf Development Corporation, Yonkers, N.Y., and chairman of Mallory-Schwarzkopf-Metals, Inc., Huntsville, Ala.

■ The U.S. Atomic Energy Commission has announced the award of 51 unclassified life science research contracts in medicine, biology, and biophysics. Sixteen of the awards, each of which covers a period of 1 year, are new projects; nine are in the field of medicine, five in biology, and two in biophysics. Thirty-five contract renewals for 1 year were awarded to allow for continuation of research already in progress. Sixteen of these are in the medical sciences, 16 in biology, and three in biophysics.

■ Fifteen students, 14 men and one woman, who are working for their doctor's degrees will receive the first group of Bell Telephone Laboratories graduate fellowships. These new awards were established

to encourage study and research in engineering and science related to communication technology. Each fellowship is for one year and carries a grant of $2000 for the fellow and another $2000 for tuition, fees, and other costs of the academic institution that he selects for his study.

■ A $10-million program of grants to the National Fund for Medical Education has been announced by the Ford Foundation. The appropriation is intended to assist the National Fund for Medical Education in its efforts to strengthen the financial support for medical schools, both public and private, throughout the United States and to develop new sources of such support.

Grants from the $10-million appropriation will be paid to the National Fund on a matching scale in a program that could last up to 10 years but might be accelerated to completion in 5 years, depending on the rate at which the National Fund develops additional support for medical education. The maximum grant in any one year would be $2 million.

The sliding formula by which the Ford Foundation will match the National Fund's receipts is designed to give particular encouragement in the early years of the plan to increasing the contributions of existing donors and to attracting new donors. In 1955 the National Fund raised approximately $2,147,000 in unearmarked funds for distribution to the nation's medical schools. If the fund's receipts are of equal magnitude in 1956, the fund would receive under the Ford Foundation's formula grants totaling 70 percent of this amount, or $1,503,486. All contributions to the National Fund in excess of the 1955 total would be matched dollar for dollar, subject to the annual maximum of $2 million.

In the Laboratories

■ Missile research with shock waves simulating flight problems at speeds exceeding 18,000 miles an hour is being conducted at the Avco Research Laboratory, a unit of Avco Manufacturing Corporation's Advanced Development Division, at Everett, Mass. The high speeds, accompanied by 15,000°F temperatures, are achieved in several shock tubes, one of which is a large tube that is believed to be the biggest research device of its kind. The research at Avco is being conducted for the Air Force.

■ The U.S. Atomic Energy Commission has announced that it has signed a contract with Atomics International, a division of North American Aviation, Inc., for the construction and operation of an experimental reactor project to be known as the organic moderated reactor experiment. The work will be conducted at the National Reactor Testing Station in Idaho at an estimated cost of $1.8 million, of which approximately $750,000 will be borne by the company.

The experiment, which is part of the commission's civilian power reactor development program, is designed to establish the technical feasibility of using the hydrocarbon diphenyl as reactor moderating and cooling material. The use of organic compounds such as diphenyl has several potential advantages, among which are low induced radioactivity, low corrosion of fuel elements, and high boiling point, which makes reasonably high-temperature systems possible.

The experiment will carry forward research previously done for the AEC by the company. It will simulate the conditions of heat transfer, temperature, and coolant flow that would exist in a practical power reactor.

The reactor will be designed to generate 5000 to 15,000 kilowatts of heat. It will use fuel elements highly enriched in uranium-235. Construction will begin this year and the reactor is expected to begin operating early in 1957.

■ The Navy and the Glenn L. Martin Company of Baltimore, Md., have announced that the Vickers Electric Division of Vickers Inc., a unit of Sperry Rand Corporation, has been selected to design and manufacture the magnetic amplifier auto-pilot unit that will control the flight of the launching vehicle that will be used for the man-made satellite that is to be launched during the International Geophysical Year.

■ The Nuclear Science and Engineering Corporation, Pittsburgh, Pa., has built an additional laboratory. This expansion reflects the organization's growing program in radiobiology. Abraham Edelmann, manager of the department of biology and medicine, moved his operations to the new building on 1 Apr., where he is continuing to direct work in radiation sterilization of food, radiation sterilization of sewage, study of radiation effects on living organisms, irradiation induced toxic factor, health-physics determinations, and other programs related to nuclear aspects of biology and medicine.

■ The Air Force and the General Dynamics Corporation's Convair Division have jointly announced that Convair's Fort Worth, Tex., plant has been awarded a contract to develop an airframe for a nuclear-powered plane.

■ The Air Force and the Lockheed Aircraft Corporation have jointly announced plans to erect aircraft facilities on a large site near Dawsonville, Ga. The facilities will be owned by the Government and operated by Lockheed in connection with the program to develop nuclear-powered aircraft. Lockheed last December announced that preliminary design studies on nuclear aircraft would be conducted at its Georgia Division at Marietta.

Miscellaneous

■ A new source of research information in many fields of industrial interest, the Naval Research Laboratory's monthly *Report of NRL Progress,* is now available to the public for the first time. The Office of Technical Services, U.S. Department of Commerce, will handle distribution of the publication. Each issue contains articles and "problem notes" concerning NRL nonclassified research and development.

■ The Association for Applied Solar Energy has announced the publication of the proceedings of the World Symposium on Applied Solar Energy, which was held last November in Phoenix, Ariz. First distribution is to the 800 registrants to the symposium. The 300-page publication contains 30 papers by internationally recognized specialists. It may be obtained by sending $5 to the secretary for the Association for Applied Solar Energy, Mr. John I. Yellott, 204 Heard Building, Phoenix, Ariz.

■ The Naval Research Laboratory has more than 40 openings for scientists and engineers for the earth satellite program. The positions are in electronics, physics, mathematics, and engineering and range in grade from GS-5 through GS-13. For information, write to Dr. W. G. Torpey, Personnel Officer, Naval Research Laboratory, Washington 25, D.C.

■ Thomas D. Nicholson of the American Museum–Hayden Planetarium describes the solar eclipse activities in Ceylon during 1955 in the lead article of the May issue of *The Scientific Monthly.* Other articles include "Physics and metaphysics" by Max Born, "Mathematicians at Ticonderoga" by D. J. Struik, "Population movements in the southern United States" by Homer L. Hitt, "The sun's energy" by Farrington Daniels, "Acid-base terminology" by Thomas P. Nash, Jr., and "Radioactive methods for geologic and biologic age determinations" by Otto Hahn. A brief description of the new AAAS headquarters building in Washington, announcement of the AAAS socio-psychological prize for 1956, and the AAAS sections call for papers for the New York meeting, along with reviews of 13 books, complete the issue.

Reports and Letters

Reversible Bleaching of Chlorophyll in vivo

It has often been suggested (*1*) that in photosynthesis, chlorophyll undergoes a reversible change. It could be either (i) transformation into a "biradical," metastable state (such as an electronic triplet state, with both free valencies on the same atom, or a tautomeric state with the two valencies at different atoms); (ii) reduction, either to a semiquinone or to a valence-saturated leuco-compound; or (iii) oxidation, either to a radical or to a saturated product.

Transformation into the metastable state has been suggested as the first step in the internal conversion of excitation energy, which limits the yield of chlorophyll fluorescence to 25 to 35 percent *in vitro* (*2, 3*) and to 2 to 3 percent *in vivo* (*3*). According to Franck (*4*), photosynthesis probably occurs by reactions of metastable chlorophyll-*a* molecules. According to Livingston and Ryan (*5*), these molecules are coresponsible for changes in the absorption spectrum of illuminated chlorophyll solutions in the photostationary state; Livingston and Ryan (*5*) and Livingston, Porter, and Windsor (*6*), using condenser flashes with synchronized absorption measurements, found that during an intense flash up to 90 percent of chlorophyll in a $10^{-6}M$ solution can be present in the metastable state. Livingston and Ryan's (*5*) steady-state experiments indicated bleaching at 403 mμ, and enhanced absorption at 439.5 to 524.5 mμ, while their flash results showed bleaching at 468, 470.5, and 477.5 mμ and enhancement of color only at 524.5 mμ. However, according to the newer flash data of Livingston, Porter, and Windsor (*6*), analyzed by Livingston (*7*), enhancement extends to the range 450 to 560 mμ, with a sharp peak at 475 mμ and a shoulder at 520 mμ.

Evstigneev and Gavrilova (*8*) found that chlorophyll-*a*, photoreduced by phenylhydrazine in toluene, has absorption bands at 518 mμ and 585 mμ. Both bands were attributed to a semiquinone, the 518-mμ band to its ion, and the 585-mμ band to the nondissociated form. Krasnovsky (*9*) has suggested that chlorophyll participates in photosynthesis by reversible reduction to the semiquinone state.

Studies of reversible photobleaching of chlorophyll in O_2-free methanol (*2, 7, 10*) and of its reversible photooxidation by Fe^{+++} in methanol (*11*) and by quinone in rigid solvents (*12*), as well as of the formation of the brown intermediate in the "phase test" (probably ionized enolchlorophyll, *13*), revealed an enhanced absorption by the unstable product in the region 450 to 550 mμ, but no sharp bands were detected, except in the last-named case, where a strong band at 524 and a weaker one at 683 mμ were noted.

It thus seems that, *in vitro*, reversibly reduced chlorophyll-*a* is characterized by bands at 525 mμ and 585 mμ and metastable chlorophyll-*a* by a band at 475 mμ; while reversible oxidation increases absorption in the same region, but apparently without producing a sharp new band. Enolization and ionization of chlorophyll-*a* leads to bands at 524 and 683 mμ.

Duysens (*14, 15*) noted that illuminated *Chlorella* cells showed, in addition to spectral changes attributable to the oxidation of a cytochrome (*14*), and perhaps also to the reduction of a pyridine nucleotide (*15*), a sharp new absorption band at 515 mμ and a somewhat smaller "negative" band (that is, selective decrease of absorption) at 478 mμ. He attributed the two changes to the transformation of an unidentified pigment, whose "dark" form absorbs at 478 mμ and whose "phototropic" form absorbs at 515 mμ. Witt (*16*) noted the 515-mμ band in plants exposed to an intense light flash. Duysens observed no change in the red region, thus apparently precluding the attribution of the effect at 515 mμ to chlorophyll (whose known phototropic forms are characterized by decreased absorption in the red band).

Using an apparatus similar in principle to that of Duysens (*17*) but with much stronger actinic light, we have been able to observe a decrease in absorption of illuminated *Chlorella* in the red. In our apparatus, the modulated photomultiplier output was amplified through three sharply tuned and six narrow band staggered stages; by means of a phase-inverting parallel twin-T tuned network, a considerable portion of the signal was negatively fed back from the fourth stage to the input. The ultrasharp tuning and increased feedback were necessitated by difficulty in discriminating between fluctuations in the fluorescence excited by the very intense actinic light and changes in the much weaker measuring light. After the ninth stage of amplification, the signal was rectified, compared, and, by means of a balanced-plate cathode follower, fed into a Brown Recorder (as in Duysens' instrument). Special checks convinced us that the observed difference spectrum was not significantly affected by changes in the fluorescence excited by the modulated photometric beam (which could possibly follow the exposure to the strong, nonmodulated actinic light).

Chlorella cells were grown in our laboratory, washed, suspended in carbonate, and refrigerated until they were used (*18*). The cells were used as taken from the refrigerator (optical density of suspension, 0.45, corrected for scattering at 680 and 740 mμ). The actinic light was furnished by a tungsten lamp 1000 w, GE 1000T20, 120 v); the entire side of the cuvette was uniformly illuminated. Before using a sample for systematic measurements (*19*), a check was made at several selected wavelengths to see whether the cells showed the normal response to illumination. The apparatus reproduced Duysens' earlier work with excellent agreement; in addition, it clearly showed absorption changes in the red.

A typical result is shown in Fig. 1. The optical density of illuminated cells is lower at 680 mμ by up to 0.25 percent. Although exact comparison with the increase at 515 mμ is not yet possible, because of the different excitation light that we had to use in the two regions, the two effects are of the same order of magnitude, thus permitting the assumption that they are both caused by a reversible change in chlorophyll-*a*. Spectroscopically this change is very similar to that observed by Krasnovsky (*9*), and by Evstigneev and Gavrilova (*8*) on reversible reduction of chlorophyll-*a* *in vitro* and by Weller (*13*) on ionization of chlorophyll enol.

The smaller changes farther in the red

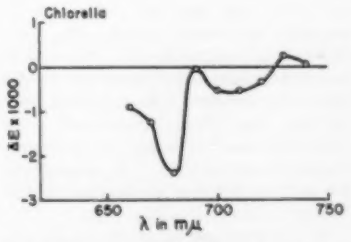

Fig. 1. Reversible bleaching of chlorophyll *in vivo*.

(decline of absorption at 710 to 715 mμ and increase at 730 mμ), as well as the bleaching at 475 mμ noted by Duysens, remain to be interpreted. Several reversible changes of chlorophyll may occur at once in the cell, for example, the formation of metastable triplet molecules may be superimposed on that of the semiquinone. It will be noted, however, that the effect observed at 475 mμ is opposite in sign to that expected from the formation of metastable chlorophyll-*a* (*20*).

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20. This work was supported by the Office of Naval Research.

19 October 1955

Clot-Retraction Promoting Factor (Retractin) in Platelets and Tissues

Transfusion of platelet-rich blood or plasma in thrombocytopenic patients is followed by temporary elevation of the number of circulating thrombocytes and by temporary correction of the increased capillary fragility, the prolonged bleeding time, and the poor utilization of prothrombin during clotting that are typical of these patients (*1*). Isolated or preserved platelets fail to survive in the patient's circulation (they are, thus, nonviable), but their administration is equally followed by improvement in prothrombin consumption. This observation led to the isolation of the platelet thromboplastic factor (*2*).

It was observed in the course of unpublished studies that clot retraction also could be favorably influenced by administration of nonviable, preserved platelets. This finding prompted the present investigation (*3*) in which we discuss preliminary evidence for a platelet constituent that is responsible for clot retraction. This factor is referred to as "retractin."

The factor that promotes clot retraction was obtained from either lyophilized or fresh human or bovine platelets. Platelets were collected and separated by the multiple centrifugation technique previously described (*4*). Only preparations were used that contained no white or red cells by microscopic examination. Platelets were washed twice with saline solution at 4°C and packed by final centrifugation at 3500 rev/min for 30 min. Some aliquots were lyophilized by a standard technique, and other aliquots were used fresh.

Three different extraction techniques were used for the separation of retractin: (i) water-acetone extraction procedure; (ii) water-ethyl ether extraction procedure; and (iii) ethyl ether cold precipitation procedure.

1) To 6 mg of lyophilized platelets or to fresh platelets from 50 ml of fresh blood were added 2.5 ml of distilled water. After 24 hr at −20°C, the preparation was brought back to 4°C. Precooled acetone, 7.5 ml in volume, was then added. After it had been shaken for 5 minutes, the mixture was stored at −20°C for 12 hours; it was then centrifuged at 3500 rev/min for 30 min at 4°C to separate all particulate matter. Microscopic examination of the supernatant acetone for platelets, platelet fragments, and ghosts was negative. A 0.5 ml volume of supernatant acetone was then dried at room temperature under 29-in. vacuum aspiration. The dry material was suspended in 0.5 ml of saline solution.

2) To packed, fresh, washed platelets from 50 ml of fresh blood, 3 ml of precooled distilled water and 5 ml of ethyl ether were added. After centrifugation at 3500 rev/min for 30 min at 4°C, three well-differentiated layers were present: (i) an upper layer containing ethyl ether; (ii) a middle layer containing a precipitate, probably of protein material and stroma, and (iii) a bottom layer containing water. The ether layer was aspirated. Aliquots of 0.5 ml were dried at room temperature under 29-in. vacuum, and the dry material was resuspended in 0.5 ml of saline solution.

3) It was observed that storage at −20°C of ethyl ether containing platelets from 50 ml of fresh blood would be followed by formation of a precipitate, which would promptly redissolve at room temperature. The cold precipitate was washed with ethyl ether twice at −20°C; it was finally dissolved in 5 ml of ethyl ether. Aliquots of 0.5-ml were dried and then resuspended in 0.5 ml of saline at room temperature.

Retractin was assayed by the two following experiments. (i) Native platelet-poor human plasma was prepared as previously described (*4*). One milliliter of plasma was then added to 0.5 ml of saline suspension of the acetone or ethyl ether extracts in chemically clean glass test tubes. After mixing of the contents, the tubes were incubated in a water bath at 37°C, and the contents were allowed to clot; retraction was observed at various intervals of time. It occurred within 15 to 40 min in most samples that contained retracin (Fig. 1). (ii) A solution containing 300 mg percent of bovine commercial fibrinogen in saline solution and a solution containing 100 N.I.H. units of bovine thrombin per milliliter were first prepared. In glass test tubes incubated in a water bath at 37°C, 0.5 ml of saline suspension of acetone or ethyl ether extracts, 0.9 ml of fibrinogen solution, and 0.1 ml of thrombin solution were introduced in rapid succession. Clot retraction occurred after approximately 20 min in the samples that contained retractin. In addition to visual inspection, the activity of retractin preparation was evaluated with a semiquantitative technique. This consisted in the measurement of the volume of serum or saline solution expressed by the spontaneous retraction of the clot after 1 hr of incubation at 37°C. The ratio

$$\frac{\text{Volume of serum or saline expressed}}{\text{Total volume of mixture}} \times 100$$

was taken as an index of clot retraction (Table 1).

Clot retraction in test tubes containing native platelet-free plasma was absent or minimal; it never exceeded 10 to 12 percent in test tubes containing fibrinogen solution.

The two ethyl ether preparations were found to be free of thromboplastic factor. On the other hand, the acetone

Fig. 1. Clot-retraction promoting effect of an acetone extract of human platelets (retractin) when added to native platelet-poor human plasma: (left) control tube containing 0.5 ml of saline solution; (right) tube containing 0.5 ml of acetone extract of platelets suspended in saline. Photograph was taken 2 hr after incubation of the test tubes in a water bath at 37°C.

Table 1. Clot-promoting effect of various extracts of human platelets on bovine fibrinogen solution clotted by thrombin. Tests were read 1 hr after completion of clotting. Figures are average of several (20) experiments. Clot retraction was measured as the percentage volume of saline obtained from a volume of 1 ml of fibrinogen solution, times 100. Similar results were obtained when native platelet-free plasma was used as substrate.

Extract	Clot retraction
Control (saline)	10.2 ± 1.5
Acetone—fresh platelets	35.7 ± 5.6
Acetone—lyophilized platelets	40.1 ± 4.3
Chloroform	34.8 ± 2.9
Ethyl ether—direct extraction	24.6 ± 6.1
Ethyl ether—precipitation	36.9 ± 3.7
Benzene	12.4 ± 0.8
Ethyl alcohol	11.8 ± 1.4
Water	9.7 ± 1.5

preparation contained some thromboplastic factor activity as assayed by our technique (*2*), although the greater activity remained in the acetone-insoluble residue. Thromboplastic factor in the acetone extract, however, could be destroyed by heating at 56°C for 2 hr and then storing at – 20°C for 48 hr. Retractin itself appeared quite stable at 56°C and, at – 20°C, kept its activity indefinitely.

Other solvents were used for the preparation of retractin from lyophilized platelets. Water, alcohol, and benzene extracts failed to show any retractin activity. Chloroform extracts were of comparable potency to acetone extracts. In addition, retractin could be obtained from tissues other than platelets. Brain supplied a potent preparation; liver and spleen a less active one; erythrocytes and platelet-free plasma failed to yield retractin.

It is generally accepted that intact platelets rather than a constituent of the platelets are needed for normal clot retraction. Glanzman (*5*) and Fonio (*6*), however, have postulated that clot retraction may be the result of a specific platelet factor. More recently, Fenichel and Seegers (*7*) and Ballerini (*8*) have reported the clot-retraction promoting effect of another possible platelet constituent, 5-hydroxytryptamine creatinine sulfate, a finding that we have been unable to confirm (*9*). Our experiments, then, seem to represent the first demonstration that platelets contain a factor promoting retraction of plasma and fibrin clots and entirely distinguishable from other platelet constituents. This factor may be found in other tissues as well and does not seem to require optimal amounts of calcium or the presence of a "serum factor" for its activity, for it will operate in a system that contains only purified thrombin and purified fibrinogen. Studies for the chemical identification of this lipid substance are in progress. *Note added in proof*: Preliminary experiments indicate that its physical, as well as chemical, properties are responsible for the activity of retractin.

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6 January 1956

Inhibition of Aerobic Phosphorylation and Pasteur Reaction by an Adrenal-Cortical Extract

A commercial adrenocortical extract, Lipo-Adrenal Cortex (Upjohn), has been reported to possess hormonal potency, *in vivo* and *in vitro*, that is not manifested by pure adrenal corticosteroids (*1*). One of these properties is lymphocytolytic activity *in vitro*. Attempts to correlate this lymphocytolytic activity with alterations in some specific enzymatic system have led to the observation that Lipo-Adrenal Cortex markedly stimulates the aerobic glycolysis of rat thymus lymphocytes and several other normal tissues (*2–4*). No stimulation of tumor glycolysis has been observed. The increase in aerobic glycolysis appears to be a true inhibition of the Pasteur reaction by a physiological preparation, for it is manifested at concentrations that have no significant influence on either respiration or anaerobic glycolysis. It has been demonstrated (*4*) that the effect is not attributable to known cortical steroids, oxygenated at the C_{14} position, that are present, for these are ineffective at the concentrations employed.

In the experiments originally reported, stimulation of glycolysis was found only with intact cells or tissue slices, and attempts to demonstrate it in homogenates were unsuccessful. It was therefore suggested (*4*) that Lipo-Adrenal Cortex may function by altering the permeability of the cell to glucose. Because permeability would not be a limiting factor in homogenized preparations, the material might fail to stimulate glycolysis in homogenates. However, an alternative possibility was that, for reasons that are obscure, the Pasteur effect could not be demonstrated with broken cell preparations of any kind. Recently, however, Meyerhof and Fiala (*5*) and Terner (*6*) reported that aerobic phosphorylation and the Pasteur effect can be demonstrated with a dried yeast preparation and with concentrated homogenates of guinea pig mammary glands and brain. Furthermore, their experiments reveal that inhibition of the Pasteur reaction by *p*-nitrophenol is accompanied by inhibition of aerobic phosphorylation.

We have therefore investigated the effect of Lipo-Adrenal Cortex on aerobic phophorylations and lactic acid formation by guinea pig brain homogenates in an effort to elucidate the mechanism of action of this preparation (*7*).

The procedure followed was essentially that described by Terner (*6*). Guinea pig brain was homogenized for 30 sec in a Potter-Elvehjem glass homogenizer in 2 volumes of isotonic KCl containing 0.024*M* $KHCO_3$ and 0.02*M* nicotinamide. The concentrated suspension was further diluted with 2 volumes of isotonic KCl. The reaction vessels contained 0.0075*M* $MgCl_2$, 0.02*M* nicotinamide, $2 \times 10^{-4}M$ diphosphopyridine nucleotide, 0.001*M* adenosine triphosphate (K salt), $10^{-5}M$ cytochrome *c*, 0.01*M* glucose, 0.005*M* hexose diphosphate (K salt), 0.00375*M* potassium phosphate buffer at *p*H 7.4, and 0.02*M* glycyl-glycine buffer at *p*H 7.4, all in isotonic KCl. The total volume was 4 ml, which included 1 ml of tissue homogenate that was tipped in from the side arm when the Warburg vessels were placed in the 37°C water bath. After a 10-minute equilibration period, readings were taken at 5-minute intervals for 20 minutes. The vessels were then iced, and protein was precipitated with either 1.5*N* perchloric acid or 10-percent trichloroacetic acid. Phosphorus was determined according to Lowry and Lopez (*8*), and lactic acid was determined by the method of Miller and Muntz (*9*) as modified by Barker and Summerson (*10*). All experiments were performed in duplicate, and all analyses were done on duplicate samples. Initial controls were precipitated at the start of the incubation period, and all experimental values were calculated by extrapolating to zero time. Initial phosphorus values were approximately 600 μg.

Dry weight was determined on a representative sample of the tissue homog-

Table 1. Effect of *p*-nitrophenol (pNP) on aerobic phosphorylation and lactic acid formation by guinea pig brain homogenates.

Concn.	Q_{O_2}	Q_P	$Q_{lactate}$
Expt. No. 1			
Control	18.1	− 4.0	6.8
$10^{-4}M$ pNP	20.2	4.0	8.6
$2\times10^{-4}M$ pNP	18.1	10.4	10.6
Expt. No. 2			
Control	17.7	−16.8	10.7
$10^{-4}M$ pNP	20.3	− 5.8	11.0
$2\times10^{-4}M$ pNP	21.3	6.9	14.2
Expt. No. 3			
Control	18.0	−11.6	13.2
$5\times10^{-5}M$ pNP	20.5	− 8.2	14.0
$10^{-4}M$ pNP	21.3	− 0.3	15.8
$2\times10^{-4}M$ pNP	20.5	9.8	18.2

enate and was corrected for the salt content of the medium. Each vessel contained 35 to 45 mg (dry weight) of tissue.

The effect of the Lipo-Adrenal Cortex, which is a cottonseed oil preparation, was determined by adding the desired volume of this material to the fluid in the vessel. Control vessels contained an equal volume of the cottonseed oil vehicle. In order to assess the significance of our results and to compare them with those of Terner, we also studied the influence of *p*-nitrophenol (pNP). This was an Eastman Kodak Company product that was recrystallized twice from water.

Q_{O_2} and $Q_{lactate}$ are the standard metabolic quotients. For purposes of convenience, aerobic phosphorylation has been expressed as Q_P. This represents microliters of H_3PO_4/mg (dry weight)/hr, according to which 1 μmole of P represents 22.4 μl. A negative value in Q_P represents disappearance of inorganic P from the medium, and a positive value, liberation of inorganic P from organic substrate.

Table 2. Effect of Lipo-Adrenal Cortex on aerobic phosphorylation and lactic acid formation by guinea pig brain homogenates.

Lipo-adrenal cortex (ml/4 ml)	Q_{O_2}	Q_P	$Q_{lactate}$
Expt. No. 1			
0	17.0	− 8.6	11.3
0.05	15.4	− 8.7	11.1
0.1	14.5	− 4.1	11.6
Expt. No. 2			
0	19.9	− 6.4	13.1
0.05	17.0	− 3.1	12.7
0.1	14.6	0.9	14.7
Expt. No. 3			
0	15.9	1.3	6.6
0.1	13.9	3.5	6.8
Expt. No. 4			
0	17.3	−10.1	13.2
0.1	15.2	− 2.4	15.1
0.2	13.2	1.5	15.2
Expt. No. 5			
0	15.6	−11.0	10.7
0.2	11.5	0	12.7
Expt. No. 6			
0	15.8	− 1.2	6.8
0.2	11.6	5.5	8.8

In confirmation of the results reported by Terner (*6*), Table 1 shows that pNP stimulates respiration and inhibits aerobic phosphorylations. Effective concentrations range from $5\times10^{-5}M$ to $2\times10^{-4}M$. Aerobic glycolysis is stimulated by $2\times10^{-4}M$ pNP, and in 2 of 3 experiments by $10^{-4}M$ pNP. The degree of stimulation is, roughly, a function of the inhibition of aerobic phosphorylation. It is apparent from experiment 2, however, that aerobic phosphorylation can be markedly inhibited without significant change in aerobic glycolysis. In most of our experiments, the controls showed higher phosphorylation and glycolysis than Terner reported. The reason for these discrepancies is not apparent; they may be due to the size or strain of guinea pig used.

The effect of Lipo-Adrenal Cortex is indicated in Table 2. Concentrations as low as 0.05 ml of the cottonseed oil preparation in a final volume of 4 ml may inhibit aerobic phosphorylation. The inhibition is considerably more marked with 0.1 and 0.2 ml, and, in most experiments, is accompanied by small but significant increases in aerobic glycolysis, 12 to 30 percent. As with pNP, inhibition of aerobic phosphorylation is not always accompanied by increased glycolysis. By comparison of Tables 1 and 2, it can be seen that the degree of stimulation of glycolysis by pNP and Lipo-Adrenal Cortex is essentially the same for the same degree of inhibition of aerobic phosphorylation. This suggests a very direct relationship between these two phenomena.

Unlike pNP, Lipo-Adrenal Cortex inhibits respiration. This inhibition did not exceed 26 percent in any of the experiments reported here. With whole cell preparations, where smaller amounts of tissue and lower concentrations of Lipo-Adrenal Cortex were effective, stimulation of glycolysis was observed without any inhibition of respiration (*4*). This suggests that the factor affecting glycolysis may be different from that which influences respiration. Unpublished experiments (*11*) on the fractionation of Lipo-Adrenal Cortex indicate that these factors can be separated.

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Tergal and Cercal Secretion of Blatta orientalis L.

A greyish viscous secretion (Fig. 1, bottom) accumulates on the terminal abdominal segments of adult females and nymphs of both sexes of *Blatta orientalis* (*1*) and nymphs of *Nyctibora lutzi* Rehn and Hebard (*2*), and on the cerci of nymphs of *Blattella germanica* (L.) (*3*).

We and George Riser, formerly of this laboratory, observed that this mucouslike secretion accumulated on the cerci and terminal abdominal segments of both sexes of nymphs of the following oviparous species of cockroaches, particularly when the insects were isolated or when small numbers were kept together in a large container: *Blattella germanica, B. vaga* Heb., *Periplaneta americana* (L.), *P. brunnea* Burm., *P. australasiae* (Fab.), *Supella supellectilium* (Serv.), *B. orientalis, Parcoblatta pensylvanica* (Deg.), *Neostylopyga rhombifolia* (Stoll), *Eurycotis floridana* (Walk.), and *Ectobius livens* (Turt.) (*4*). We have not found the secretion on isolated nymphs of the viviparous species *Diploptera dytiscoides* (Serv.) or on the following false ovoviviparous species: *Blaberus craniifer* Burm., *Pycnoscelus surinamensis* (L.), *Leucophaea maderae* (Fab.), and *Nauphoeta cinerea* (Oliv.).

In *Blatta orientalis*, the material is secreted by the cerci and by glandular cells in tergites 6 and 7. We removed the cerci of oriental cockroach nymphs, and the secretion built up quickly on the tergites.

We collected secretion weekly from isolated nymphs and, after several months, had accumulated enough for analysis. The dried secretion was tan-colored and amorphous. It became soft and moist at 166°C and began to decompose by charring at approximately 205°C. It

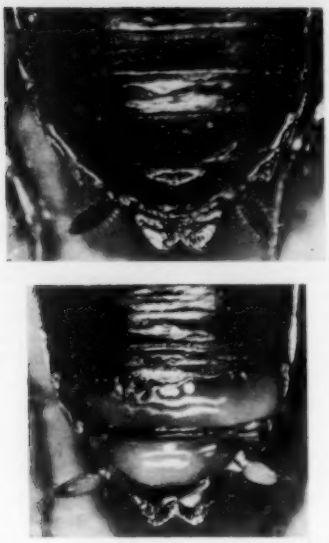

Fig. 1. Terminal, dorsal abdominal segments of adult females of *Blatta orientalis* (×4.6). (Top) Specimen from crowded culture has very little secretion on the tergites and cerci. (Bottom) Isolated virgin 2 weeks old accumulated a large amount of cloudy secretion on the sixth and seventh tergites and the cerci. The clear fluid on the supra-anal plate and around the bases of the cerci was probably exuded from the anus when the insect was anesthetized with CO_2. [Photographs by E. R. Willis]

was soluble in water and insoluble in petroleum ether.

The analysis of this material was as follows: An estimated 10 percent by weight of the dry sample was combined carbohydrate as detected by the anthrone reaction. A negative test for free sugars as reducing sugars was obtained using triphenyltetrazolium chloride. No reducing sugar was present after hydrolysis, but a polysaccharide was indicated by its reaction with aniline phthalate reagent. Chlorides and phosphorous were present qualitatively in trace amounts, further indicating the inhomogeneity of the sample. There was an average of 1.90 percent ash. Averages of duplicate elemental analyses gave the following: 14.30 percent nitrogen, 45.85 percent carbon, 7.21 percent hydrogen, and 0.45 percent sulfur.

About 90 percent of the sample was calculated to be protein. The following amino acids, qualitatively identified by paper chromatography, were present in the protein hydrolyzate: aspartic acid, glutamic acid, serine, glycine, tyrosine, alanine, methionine, leucine (isoleucine?), proline, and lysine. If one assumes that the entire amount of sulfur was found in methionine, since no cystine was present, then 2.1 percent methionine was present. This order of magnitude was indicated in the methionine spot on the two-dimensional paper chromatogram. Four percent of the total nitrogen existed as the free amino acid glycine and an unidentified free di- or tripeptide, as estimated by two-dimensional paper chromatography.

The function of the secretion is unknown; the significance, if any, of the absence of this material in viviparous and false ovoviviparous cockroaches is not understood. Stock and O'Farrell (*3*) suggested that in *Blattella germanica* the secretion may help keep the young nymphs together in loose aggregations; but our observations of colonies of cockroaches that secrete this material do not support this idea. Although we have seen cockroaches in aggregates, we have never seen any form of "webbing" or fibers that might tend to keep the insects together.

The fact that the material accumulates rapidly on the backs of isolated individuals (Fig. 1) indicates that in crowded cultures (where the secretion is rarely seen) the secretion is either rubbed off or perhaps eaten off by the insects. The oriental cockroach is capable of eating the material despite its viscous nature. On 9 May 1952, Edna Roth and Marc Roth observed a newly emerged adult of *Blatta orientalis*, which had been isolated for several weeks as a nymph, eat its own secretion and exuvia. If a type of trophallaxis exists among some species of cockroaches, whereby nymphs eat this material off each other, it is conceivable that the secretion, high in protein, could serve as a supplemental food.

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13 October 1955

Distribution of Alpha-Radioactivity in Certain Forest Types

It is known that various types of forests accumulate calcium and other bases in the organic matter layer at the surface of their soils (*1*). In the current study, a similar accumulation was found for alpha-emitting radioactive substances.

Table 1. Vertical distribution of alpha-radioactivity. Units are counts per hour, per square centimeter.

Vertical position in forest	Average	
	Wis.	S. Appalachians
Living leaves of dominant tree	1.74 ± 0.21	4.63 ± 0.51
A_0 layer beneath dominant tree	8.28 ± 0.79	12.68 ± 1.13
A_1 layer of soil	4.32 ± 0.68	3.31 ± 0.39
C layer of soil	1.11 ± 0.10	0.85 ± 0.08

Eighty stands of hardwood and conifer forest in Wisconsin and in the southern Appalachian region were examined in 1953 and 1954 for alpha-radioactivity by the scintillometer method of Ockerman and Daniels (*2*).

Analyses were made of leaves of the dominant trees, of the dead and decomposing litter (A_0 layer) beneath those trees, and of the topsoil (A_1 layer) and subsoil (C layer). All samples were ashed at 600°C for 8 hours, ground to pass 100 mesh, and stored for 2 to 4 weeks before testing. The results are presented as counts per hour, per square centimeter of the test surface in an "infinitely thick" layer (*3*). The results for individual samples are the averages of duplicate tests, each of which was counted to a statistical precision of ± 20 percent at the 90-percent confidence level by the accumulation of at least 70 counts above background. The background counts themselves did not exceed 0.1 to 0.2 counts/hr cm^2. The variations shown in Table 1 are standard errors.

The vertical distribution of alpha-radioactivity from subsoil to living leaves was similar in all forest types that were examined in both geographic regions, as shown by the average values in Table 1. The subsoil values were remarkably constant in all stands, but the intensity of the maximum activity in the A_0 layer varied greatly in different forest types. Hardwood forests in the prairie-forest border region of southwestern Wisconsin (*4*), which were dominated by species of *Quercus, Carya, Tilia,* or *Acer,* were uniformly low in alpha-radioactivity, while mixed conifer-hardwood or pure conifer forests in northeastern Wisconsin, the Cumberland Mountains, and the Great Smoky Mountains were usually high in activity (Table 2). The highest values in the A_0 layer were found in forests that were dominated by species of *Abies, Picea, Tsuga,* and *Fagus.* All such forests examined were characterized by a relatively low July temperature (67°F or less), a soil acidity of *p*H 5.5 or less, and an A_0 layer of the mor humus type (*1*) which weighed 1.5 kg or more per

Table 2. Alpha-radioactivity of the A_0 layer in different forest types. Units are counts per hour, per square centimeter.

Species dominant in forest	Average		
	S.W. Wis.	N.E. Wis.	S. Appalachians
Acer saccharum	2.63	6.77	8.35
Tilia americana	3.30		
Quercus sp.	3.28		
Carya sp.	3.42		8.46
Pinus sp.		5.11	
Fagus grandifolia		6.61	8.75
Tsuga canadensis		9.14	9.87
Abies sp.		6.70	20.70

square meter. The retention of the alpha-emitting substances in the mor humus may be related to the specific nature of its chelating humic acids (*5*). Further work on this relationship is in progress.

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17 October 1955

Acute Myeloid Leukemia Following Prolonged Iodine-131 Therapy for Metastatic Thyroid Carcinoma

There is considerable current interest in the role of radiation in producing leukemia. Reports to date of both human and animal studies (*1*, *2*) have been concerned with the results of external radiation. We are reporting here the occurrence of leukemia subsequent to prolonged irradiation exclusively by an internally administered radioisotope (*3*).

Two instances of acute leukemia have developed in the Montefiore Hospital series (*4*, *5*) of sixteen patients with metastatic thyroid carcinoma who have been treated intensively with radioiodine. The radioiodine administered to this group of patients, commencing in 1943, ranged from 195 mc to 2290 mc over a 6-month to 9-year interval. A detailed clinical report of these two cases is in preparation.

The first patient (J.F.) to develop leukemia received 13 therapeutic doses of I^{131} from 1947 to 1951, totalling 1455 mc. He was 58 years old when therapy started. Employing the methods and data reported previously (*6*), we estimate that he received a cumulative blood radiation dose of about 600 rad (Fig. 1). The amount of generalized body radiation received is, usually, about half the blood radiation dose (*6*). The patient died in 1951 with a clinical picture of acute myeloid leukemia. Post-mortem studies revealed, among other findings, myeloid leukemia involving bone marrow, spleen, liver, and lymph nodes, as well as anaplastic carcinoma of the thyroid metastasizing to cervical lymph nodes, skull, spine and lungs.

The second patient (B.L.) received a total of 1730 mc of I^{131} from 1948 to 1953, which we grossly estimate delivered 550 rad to the blood. She was 61 years old when therapy was initiated. As indicated in Fig. 2, this patient received 20 therapeutic doses of radioiodine, the first two of which were administered at Mt. Sinai Hospital, New York. Although that hospital reported that the white blood count was 6500, the patient had recurrent leucopenia after she came under our observation. The leucopenia, associated with a persistent severe anemia, became more marked in her last 3 years. In June 1953, her differential count began to show abnormal forms and high "lymphocyte" counts. In September 1954, the white blood count began to rise rapidly, with a high proportion of myeloblasts, and the patient was readmitted to the hospital because of persistent bleeding. She died 5 weeks later, exhibiting the clinical and hematological features of acute myeloid leukemia. The autopsy findings included acute myeloid leukemia with infiltrates in bone marrow, spleen, liver, lungs, kidneys, and pancreas, and metastatic thyroid adenocarcinoma in the skull.

A causal relationship between radioiodine therapy and leukemia is not definitely established by these results. However, the occurrence of these two cases in a series of 16 patients tends strongly to validate the correlation. Moreover, the experimental production of leukemia

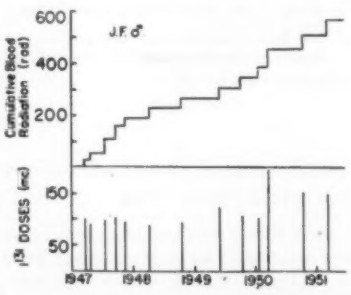

Fig. 1. Patient J.F. The cumulative blood radiation and the therapeutic doses of I^{131} administered are plotted as a function of time.

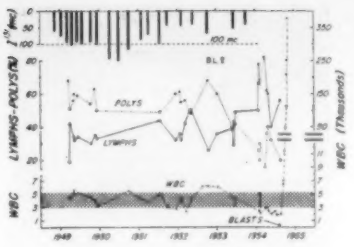

Fig. 2. Patient B.L. Variation of the white blood cell count, lymphocytes, and polycytes with time. The bars at the top indicate the occurrence and magnitude of the radioiodine doses administered to the patient.

in animals by radiation (*7*), the frequent occurrence of leukemia among radiologists as compared with other physicians (*8*), and the high incidence of myeloid leukemia among the survivors of the Hiroshima and Nagasaki atomic explosions (*1*) are all consistent with the existence of a relationship between the radiation received during massive radioiodine therapy and the subsequent development of leukemia. Furthermore, two case histories have been published (*9*) in which development of acute leukemia has been reported subsequent to external radiation followed by I^{131} therapy for thyroid carcinoma.

It is noteworthy that the type of leukemia developed by both patients reported here was acute. This is consistent with the recent report of Moloney (*10*) that, of 92 cases of leukemia occurring among survivors of atomic bombing, 52 were acute or subacute and only 40 were chronic. Moloney's observations, as well as the relatively small number of cases of chronic leukemia among radiologists, as compiled by March (*8*), seem incompatible with the view that leukemia following irradiation is generally chronic (*2*). The delay in the onset of leukemia, which occurred 4 and 5 years, respectively, after initiation of radioiodine therapy, is consonant with Moloney's observations (*10*) that in survivors of atomic bombing the disease has had a latent period of 2 to 9 years, appearing most frequently 4 to 6 years after exposure.

The body radiation dose received during I^{131} therapy for hyperthyroidism is at most a few percent of that received by patients who are treated for thyroid carcinoma, and it is considerably smaller than the apparent minimum leukemogenic dose, which Moloney (*10*) found to be about that required to produce severe radiation complaints. Acute systemic radiation effects are not encountered in the course of I^{131} therapy for hyperthyroidism. It is, therefore, unlikely that the incidence of leukemia in

patients treated for hyperthyroidism with radioiodine will prove to be significantly higher than the occurrence of leukemia in the general population.

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24 October 1955

Palynological Study of Pleistocene Deposits on Banks Island, Northwest Territories, Canada

In connection with palynological studies made on a variety of Pleistocene deposits in Canada, I have examined several samples from Banks Island, District of Franklin, for plant microfossils.

The locality from which the samples were collected is in the general vicinity of Cape Kellett along the western shore of the Banks Island, approximate lat. 72°N, long. 120°W. According to Pleistocene geologists, this area was not glaciated during the Pleistocene time. However, deposits associated with glaciations cover this part of the island and form a shore cliff more than 100 ft high at the sampling locality. The fine plant debris occurs as lenses and streaks in the stratified gravels and silts.

The samples were collected from these beds of plant debris. The results obtained from palynological studies of two of the samples (No. 4 and No. 17) are given in Tables 1 and 2. In addition to the pollens listed in Table 1, fossil remains of fungus, fragments of bark and woody tissue, stomata of coniferous trees, and spores of mosses were also identified in sample No. 4. In sample No. 17 (Table 2) were further identified the spores of *Sphagnum* and stomata, fungus remains, and fragments of brown mosses. Among the nonarboreal pollens were identified pollen grains of Ericaceae, Caryophyllaceae, Cyperaceae, Gramineae, Polemoniaceae, and two pollen grains of *Ephedra* sp.

The palynological study suggests that, at the time when the beds from which the samples were collected were deposited, considerably more favorable climatic conditions than those now prevailing must have been present on Banks Island to account for the assemblage of pollen grains, spores, and other plant fossils present in these deposits. The total assemblage and relative numbers of pollen grains further suggest local forest coverage. The present timber line lies about 200 mi southwest of Banks Island.

The presence of pollen grains of *Ulmus*, *Tilia*, and *Carya* as well as *Tsuga heterophylla* made me think of the possibility that some of these pollen grains may have been transported by wind from a distant locality several hundred miles away. Even if that is true, these trees must have had a much wider distribution in earlier Pleistocene time than they do now. The lithological character of the material (gravel and silty sand) suggests rather rapid sedimentation, in which case the very low number of grains of tree pollen that would be transported by wind from a distant locality would not enter strongly into the assemblage of pollen grains and spores. This is also shown by the fact that the number of pollen grains and spores per unit volume of material is high. The high frequency cannot be described as primarily the result of a slow accumulation of pollen grains and spores transported from a distant locality by wind. The possibility of contamination seems unlikely, for several other samples that were analyzed at the same time did not yield any pollen grains at all. In addition, particular care was exercised to avoid contamination during analysis.

Of special interest is the discovery of pollen grains of *Ephedra* sp. in this material (Fig. 1). For identification, the fossil pollen grains were compared with modern reference material and descriptions of *Ephedra* pollen in palynological texts and with photographs and descriptions of modern and fossil *Ephedra* pollen given by Andersen (*1*).

The present distribution of *Ephedra* is limited to the southern parts of the Rocky Mountains (*2*). However, pollen grains of *Ephedra* have recently been found in the early postglacial sediments in the Great Lakes region by me and by Andersen (*1*). As also pointed out by Andersen (*2*, p. 19) *Ephedra* is not specific in its thermal requirements and is able to exist in edaphically favorable localities with strong isolation. In spite of that, the presence of *Ephedra* on Banks Island must involve considerable migration of the plant. It seems more likely that the species previously had a much wider distribution and that the successive Pleistocene glaciations eliminated it within the reach of the ice sheets.

As a conclusion, I suggest, on basis of palynological studies, that the long, warm interglacial periods such as Sangamon, Yarmouth, and Aftonian are probably represented by accumulation of organic deposits in the Far North and that further studies may disclose a much fuller sequence of Pleistocene deposits in the northern regions, outside the maximum extent of the Pleistocene ice sheets, than has been expected so far.

Table 1. Analysis of sample No. 4. This sample was collected from a bed of plant debris that was approximately 30 ft above sea level and 6 mi north of Cape Kellett.

Plant	Pollen grains identified (No.)
Picea	28
Pinus	43
Betula	32
Alnus	Abundant (local overrepresentation)
Tsuga heterophylla (?)	10
Ulmus	2
Tilia	2
Carya	1
Nonarboreal pollen, unidentified	17
Ericaceae	2
Polypodiaceae	1

Table 2. Analysis of sample No. 17. This sample was collected from a lens of plant debris that was approximately 20 ft above sea level and 7 miles east of Cape Kellett.

Plant	Pollen grains identified (No.)
Picea	6
Pinus	11
Betula	17
Alnus	16
Tsuga heterophylla	1
Tsuga mertensiana	1
Carya	3
Ulmus	1
Salix	1
Compare *Fagus*	1
Nonarboreal pollen, unidentified	32

Fig. 1. Photomicrograph of a pollen grain of *Ephedra*, found as fossil in Pleistocene deposits on Banks Island. Longest axis of the pollen grain measures 48 μ.

Phytogeographical studies also would benefit by further palynological investigations, for these investigations greatly help to trace the migrations of plants during the past.

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17 October 1955

Conduction Block in Peripheral Nerve Produced by Oxygen at High Pressure

Paul Bert demonstrated inexcitability of frog sciatic nerve-muscle preparations that were exposed to 15 "superoxygenated atmospheres" for 2 hours (*1*). Hill and Macleod (*2*) and Bean and Bohr (*3*) extended these studies, confirming the toxic action of oxygen at high partial pressure (OHP) on the nerve-muscle preparation. Since the toxic effects noted in the nerve-muscle preparations (progressively decreasing contractile response to stimulation of the nerve and disappearance of the treppe phenomenon) could be attributed to either muscle, myoneural junction, or nerve dysfunction, singly or in combination, they offer no proof of neuronal poisoning by OHP. Accordingly, we have investigated the effects of OHP on peripheral nerve alone as a functioning unit.

Twenty-six experiments were performed on frog sciatic nerve. The nerves were excised, placed in a phosphate-buffered Ringer's solution (*4*), and suspended 1 hour later on an array of silver electrodes in a plastic block. This was placed in a pressure chamber (2 in. in diameter by 4 in. long) that was provided with electric feed-throughs for stimulating, voltage recording, and thermocouple leads. The nerves were kept moist by placing gauze sponges that had been soaked in Ringer's solution over the plastic block.

Usually the nerves were continuously stimulated throughout an experiment at 20 pulses/sec, 0.1 msec duration, beginning as soon as the chamber was sealed. Stimulus strength was just supramaximal for alpha fibers (generally 0.5 v), and the amplifier was adjusted so that the amplitude of each nerve action potential was displayed initially at 77 mm on an oscilloscope.

Control and experimental nerves were unpaired and selected at random, and the spike amplitude was measured every 5 minutes. After an observation period of 30 minutes, the chamber was flushed with the gas being investigated for 2 minutes, sealed, and brought to pressure in 5 to 10 minutes. Experiments were conducted at two levels, 1 and 12 atm (gage). The temperature during compression never increased more than 3°C and returned to precompression levels within 5 minutes. Figure 1 illustrates the extent of conduction block produced in peripheral nerve by pure oxygen under these conditions (complete conduction block being defined as the absence of the action potential in a nerve when stimulated with the initial electric stimulus parameters).

A standard t test (*5*) for significant differences in the means of the two groups (6 control and 9 experimental nerves) indicated that $p < 0.02$ at 3½ hours and $p < 0.01$ at 4 hours.

In a series of nerves exposed to a 5-percent CO_2–95-percent O_2 mixture, the stimulus threshold rose immediately upon compression; but if, after the chamber reached 12 atm, the stimulus voltage was increased approximately 100 percent (to about 1 v) so that the precompression spike amplitude was obtained, the nerves were blocked in the same fashion as ones at 12 atm of oxygen but with a significantly shorter latent period ($p < 0.01$). Mean time for block with 5-percent CO_2–95-percent O_2 mixture at 12 atm was 3 hours, compared with 4.5 hours for oxygen at 12 atm. Evidence was obtained that hyperoxic conduction block occurs at 10 atm and lower pressures with longer latencies, but a complete spectrum of pressures was not investigated.

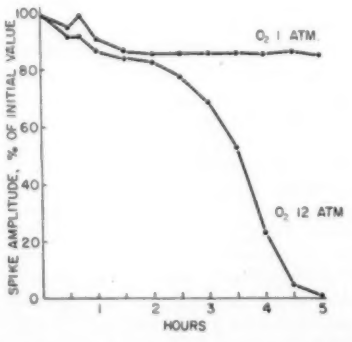

Fig. 1. Time course of conduction block produced in frog sciatic nerve stimulated with 0.5 v, 0.1-msec duration, 20/sec pulses in 12 atm of oxygen, compared with controls in 1 atm of oxygen that were stimulated in the same fashion. Spike amplitudes are mean values.

As in oxygen poisoning of muscle (*3*), peripheral nerve usually shows a partial recovery from hyperoxic conduction block when it is returned to air at 1 atm provided that the block is not maintained more than a few minutes. No complete recoveries occurred in our series. Nerves in which conduction was blocked by 5-percent CO_2–95-percent O_2 showed partial recovery sooner (within 10 minutes) and more completely upon decompression than those that were blocked by oxygen alone.

Nerve activity resulting from continuous stimulation neither seems to modify nor to be essential for the production of conduction block. A group of nerves was exposed to 12 atm of oxygen and stimulated every 30 minutes (for no more than 30 sec, just long enough to measure the spike amplitude). A second group of nerves was exposed to 12 atm of oxygen and continuously stimulated. No significant difference was observed between the two groups with respect to the time course of conduction block.

Hyperoxic conduction block in nerve may result from a direct toxic action of oxygen on the oxidative processes that are essential for maintenance of the membrane potential and impulse transmission. Inactivation of thiol (-SH group) enzymes (*6*) by increased formation of oxidizing free radicals (*7*) is a recently advanced explanation of this direct toxicity.

It has been reported that carbon dioxide decreases the latency of central nervous system manifestations of OHP (*8*), and it is interesting to note that it also decreases the latency of hyperoxic conduction block in peripheral nerve. Whether its efficacy in potentiating the block consists in changing the *p*H, increasing the membrane permeability, or involves some more obscure mechanism remains unknown. As yet, there is no evidence that OHP produces conduction block in the central nervous system, but hyperoxic conduction block may well play a role in the neural insult that initiates hyperoxic convulsions. The length of exposure and the pressure required to produce even mild nerve block in these experiments are greater than

those required to produce hyperoxic seizures, but it is conceivable that conduction deficiencies may develop more quickly and with lower pressures of oxygen in tissue with a circulation.

Oxygen at high pressure (12 atm) produces conduction block in frog peripheral nerve. The block is partially reversible if it is not maintained more than a few minutes. The block caused by 5-percent CO_2–95-percent O_2 has a shorter latency, and its reversibility is more pronounced than that of the block produced by oxygen alone. The presence or absence of activity in nerve caused by continuous stimulation does not affect the time course of hyperoxic conduction block (*9*).

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27 October 1955

Basis for After-Discharge in the Median Giant Axon of the Earthworm

The ventral nerve cord of the earthworm (*Lumbricus terrestris*) contains three giant axons, many smaller nerves, and a complex neuropile. The giant axons are endowed with many synapses that range from endings of smaller nerves on the giant axons to the segmental transverse septa that interrupt the substance of the latter (*1*). Because of this abundance, the giant axons are interesting material for the study of some fundamental properties of interneuronal relationship (*2*).

Isolated ventral nerve cords were immersed in an earthworm saline (*3*) and stimulated with a pair of surface electrodes. Responses were simultaneously recorded with a pair of electrodes on the entire nerve cord and one or two prefilled capillary microelectrodes (*4*) in the median giant axon. Action potentials recorded from the intracellular loci ranged from 80 to 100 mv; these were 25 to 35 mv beyond the resting potential of 50 to 70 mv. Svaetichin (*5*) has reported the same limits for the resting potential obtained with an axially inserted microelectrode.

At room temperature of 19° to 24°C, the internally recorded spike lasted 1 msec, but it was followed by a slight negativity that persisted for about 4 msec. Occasionally, with one brief stimulus, two or more responses occurred. The first direct response to the shock rose rapidly, while the later ones were often preceded by a prepotential that rose more slowly. The nature of the repetitive discharge could be resolved by applying two brief shocks in rapid succession. The second response elicited in the relative refractory period was followed by a sequence of small and additive potentials. These were highly variable in number, amplitude, frequency, and time and site of occurrence.

Figure 1 illustrates a case in which activity was recorded from three sites of a preparation. The entire nerve cord was stimulated at one end, and impulses were recorded from the other end with external electrodes. Two microelectrodes, 11.3 mm apart, were placed in the median giant axon in a stretch between the surface electrodes. Response to the first stimulus, which was threshold for the median giant axon alone, was recorded earliest at the two microelectrodes and, after the appropriate conduction time, on the external leads. The strong second stimulus that was applied in the relative refractory period reexcited the axon, but the internally recorded responses were smaller and the externally recorded response was markedly delayed. The external trace, but neither internal trace, also registered the spike of the lateral giants evoked by the strong stimulus. The trace of one of the microelectrodes, however, remained elevated above the base line and carried numerous small peaks. The trace of the other had only a brief additional potential soon after the spike. About 7 msec after the second stimulus another spike developed in the giant axon. Since the small potentials began during the absolute refractory period of the giant axon, they could not be produced by the same mechanism responsible for the electrically excitable spike. Owing to their local nonpropagating nature, low amplitude, frequency of repetition, and additiveness, these potentials are probably synaptic, developing at the terminations of small nerve fibers on the giant axon. This junctionally

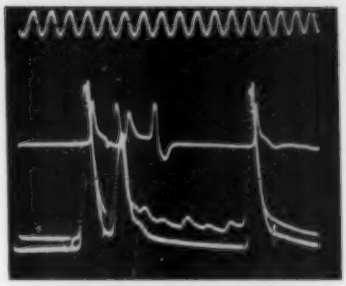

Fig. 1. Simultaneous recording from three sites of the nerve cord (external leads) and median giant axon (internal microelectrodes). The upper trace is the external recording, which is also the base line for the resting potentials. The latter are 72 and 74 mv; spike heights are 98 and 110 mv. The distance between the stimulating cathode and proximal microelectrode was 8.5 mm; between the microelectrodes, 11.3 mm; and between the distal microelectrode and the first external lead, 3.5 mm. The two directly coupled beams are not coincident. Time 1000 cycles.

elicited postsynaptic activity of the median giant axon is then responsible for reexciting the fiber.

Other evidence indicates that the activity of the small nerve fibers that excite the giant axon synaptically are themselves initiated, at least in part, by previous activity of the giant axon. Thus, small fiber activity, as well as synaptic potentials and late all-or-none discharges, disappears when the second stimulus is applied during the absolute refractory period of the giant axon. The evidence, therefore, suggests the presence of a closed circuit containing efferents from and afferents into the median giant axon. It also indicates that "reentry" is an important factor in the after-discharge following a brief stimulus to this preparation.

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17 October 1955

Observations on the Cortical Mechanism of EEG Activation Accompanying Behavioral Arousal

Consideration of the special properties of dendrites has led to the hypothesis that the oscillatory potentials observed in the electroencephalogram represent variations in graded, electrotonically summated activity of cortical dendrites (*1*). This theory has been supported by the observations that the changes in electrocortical activity produced in the unanesthetized cat by the psychotogenic drug, lysergic acid diethylamide (LSD-25), is attributable predominately to an inhibition of axo-dendritic synaptic activity (*2*). This report (*3*) presents further evidence consistent with the dendritic origin of brain waves by establishing a direct correlation between the dendritic potential tested in isolation and alterations in the amplitude-frequency characteristics of electrocortical activity.

Experiments were performed on unanesthetized, paralyzed cats that had initially been prepared with ether and local skin anesthetization. Single shocks were delivered every 2 sec to the cortical surface 2 mm from bipolar transcortical electrodes that recorded the evoked surface negative potential assignable to the activity of apical dendrites (*4*). The electrocorticogram was recorded continuously in correlation with oscilloscopic registration of the testing dendritic responses. Variations in the directly evoked dendritic response were produced by high-frequency stimulation of the bulbar reticular system that caused at the same time characteristic electrocortical activation (*5*). In addition to this, the effects of cortical polarization on the dentritic response were studied during brain-stem stimulation.

Figure 1 shows the effects of brain-stem stimulation on the spontaneous electrocortical activity and on the tested, directly evoked dendritic response. Accompanying the "desynchronization" of resting activity on stimulation (first arrow), a marked inhibition in the dendritic responses occurred. Both persisted many seconds after brain-stem stimulation (second arrow). Along with the return of the resting rhythm, the dendritic potential returned to initial amplitude.

Further studies to determine the nature of the alteration in dendritic activity by brain-stem stimulation are summarized in Fig. 2. The testing dendritic response (*A*, 1) is decreased by brain-stem stimulation (*A*, 2, 4), but superposed anodal polarization of the cortex temporarily enhances the responses. The dendritic response returned to initial level (*A*, 5) 15 sec after cessation of brain-stem stimulation. The same sequence of events is shown in series *B*, 6–10, with a stronger cortical testing stimulus. In all cases, brain-stem stimulation reduced the dendritic responses. The same effect was produced by cathodal polarization of the cortex (*C*, 12). These results suggest that iterative stimulation of the brain stem activates cortical neurons which inhibit apical dendrites. The inhibitory elements are selectively activated by cathodal polarization of the cortex.

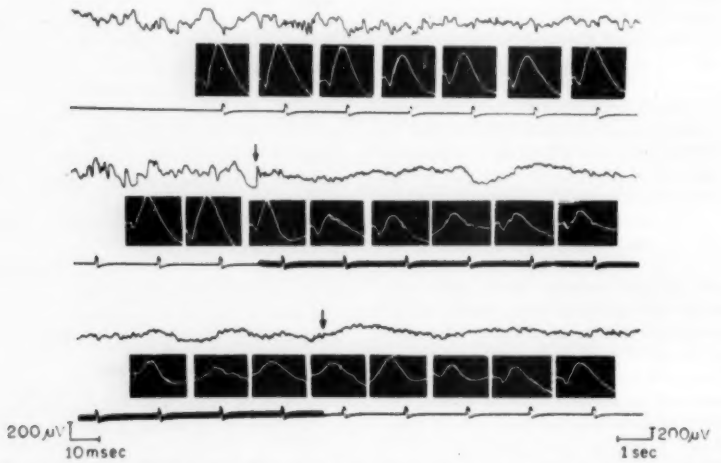

Fig. 1. Signal marker below oscillograms indicates time during recording of electrocorticogram (ECG) that testing dendritic response was evoked from anterior supra-sylvian gyrus. ECG recorded bipolarly from post-sigmoid to anterior supra-sylvian gyrus. *First arrow*: beginning of 300/sec stimulation of brain stem; *second arrow*: end of stimulation. Calibration: (left) dendritic response; (right) ECG.

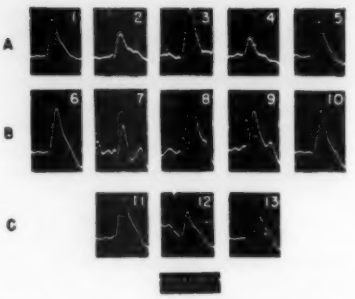

Fig. 2. *A*, *B*, effects of superposed anodal polarization of cortex on testing dendritic response during brain-stem stimulation. *C*, effect of cathodal polarization of cortex, 12, on dendritic response without brain-stem stimulation; (*C*, 11) before cathodal polarization; (*C*, 13) 10 sec after cessation of polarization. Calibration: 100 cy/sec; 100 μv.

The results of the present study indicate that high-frequency stimulation of the ascending bulbar reticular system alters the synaptic activity of cortical dendrites. Persisting dendritic inhibition resulting from reticulocortical synaptic excitation is believed to underlie the alteration in electrocortical activity that is associated with behavioral arousal.

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6 October 1955

Very late in life, when he was studying geometry, someone said to Lacydes, "Is it then a time for you to be learning now?" "If it is not," he replied, "when will it be?"—DIOGENES LAERTIUS, *in The Lives and Opinions of Eminent Philosophers.*

Book Reviews

Temperatur und Leben. H. Precht, J. Christophersen, H. Hensel. Springer, Berlin, 1955. xii + 514 pp. Illus. DM 78.

Temperature, as the authors justly state, "is one of the most important ambient factors that determine life on earth." However, no comprehensive review on temperature and life seems to have appeared since the books by Przibram, Bĕhlerádek, and others, which are now obsolete. The present volume fills this gap in the most satisfactory way, and the topic in question has found as superb a presentation as few others in modern biology have found. Because it is impossible to do justice to the wealth of material in a review, only the contents of the volume can be briefly indicated. Precht surveys poikilothermic animals and plants. After a brief introduction on the physicochemical foundations, the influence of temperature on life processes is treated in view of metabolic and developmental processes, adaptations, seasons, extreme temperatures, modifications, mutations, body temperature, behavior, distribution of organisms, and so forth. Christophersen reviews the microorganisms: influence of temperature on growth, multiplication, metabolism, adaptations, killing by heat and cold, heat resistance of microorganisms and enzymes, thermophilic organisms, refrigeration of foodstuffs, and temperature influence on spores, on poisoning, and so forth. The part by Hensel concerns man and homeotherms: body temperature, homeothermy as a feedback mechanism, formation and loss of body heat, nervous and hormonal controls, thermoreceptors, changes in thermoregulation, acclimation, temperature limits, ontogenetic development of homeothermy, hibernation, and influence of temperature on the geographic distribution of homeotherms.

As can be seen from this sketchy list, there is hardly a topic within the scope of the title that has not been fully treated. The comprehensiveness of the treatment is illustrated by the fact that the list of authors quoted contains about 3000 names. However, the presentations are much more than an enumeration of an enormous number of facts. The presentation is based largely on the authors' own work, and everywhere facts are fitted into a modern theoretical framework.

This standard work will prove indispensable for anyone working in the many fields of physiology, biology, and medicine that are connected with this topic.

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Modern Physics. John C. Slater. McGraw-Hill, New York–London, 1955. xi + 322 pp. Illus. $5.50.

John C. Slater of the Massachusetts Institute of Technology has himself contributed substantially to many of the fields discussed in his stimulating book, which conveys much of the spirit of research as well as a balanced view of the historical development and basic concepts of modern physics. Even readers familiar with Slater's earlier excellent and concise textbooks in theoretical physics will be amazed at the number of topics in this volume.

The first two chapters include the development of the atomic theory, kinetic theory and specific heats, electron theory, and relativity; as an illustration of the versatility of physical theories in the hands of great physicists, Slater includes here an especially interesting summary of the many successes of the classical electron theory of matter in explaining phenomena that are now considered to be inherently quantum-mechanical. The next three chapters treat the beginning of the quantum theory and the development of the Bohr theory of the atom. Then x-rays and atomic and molecular spectra are discussed in considerable detail, followed by a chapter that the author describes as a "very superficial sketch" of wave mechanics.

The next chapter of only 26 pages indicates how the quantum theory and Fermi statistics explain the main properties of atoms, molecules, and solids; especially outstanding here is the author's lucid summary of qualitative features of the Hartree self-consistent field method, the method of molecular orbitals, and other approximation techniques for the treatment of many body problems. The concluding chapter discusses nuclear physics and high-energy particles; among many other topics, this chapter includes a historical introduction, positrons and the Dirac theory of the electron, particle accelerators, nuclear reactions and nuclear-energy levels, fission and reactors, nuclear spins and magnetic moments, a discussion of nuclear forces and nuclear structure, cosmic rays, and elementary particles.

With so many topics in one volume, theoretical discussions are necessarily highly abbreviated, with many critical points omitted or introduced abruptly by "we find that . . ." or "it turns out that . . ." Many concepts are used without full explanation, so that the book will be comprehensible only to students who have already had approximately the equivalent of a B.S. degree in physics; for example, in the first chapter such concepts as Doppler effect and radiation pressure are utilized without definition, and Fourier analysis is tacitly employed. Thus the text is not especially suited for students who are learning modern physics for the first time but would be useful to students who are reviewing for B.S. or M.S. comprehensive examinations in physics, and I have recommended it for this purpose, particularly when the well-chosen problems at the end of each chapter are used. The highly readable informal style should also attract all instructors of physics or other physicists who wish to have a well-balanced summary of the essential features and spirit of modern physics.

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The Alkaloids, Chemistry and Physiology. vol. V. *Pharmacology.* R. H. F. Manske, Ed. Academic Press, New York, 1955. ix + 388 pp. $9.50.

This is the last of a series of five volumes dealing with the chemistry and pharmacology of alkaloids; it is designed to cover the latter aspects of these compounds. The material is arranged in 11 chapters prepared by different authors, namely, "Narcotics and analgesics," "Cardioactive alkaloids," "Respiratory stimulants," "Antimalarials," "Uterine stimulants," "Alkaloids as local anesthetics," "Pressor alkaloids," "Mydriatic alkaloids," and "Curare-like effects"; these nine are followed by two short chapters on "The lycopodium alkaloids" and on "Minor alkaloids of unknown structure." The various chapters are annotated with numerous references.

The title of the volume is not well chosen in that *physiology* refers to the

science which deals with normal vital phenomena manifested by animals or plants, or the function of the living organism and its parts. This is in contrast to *pharmacology*, which means the sum of knowledge regarding drugs; and *pharmacodynamics*, which means the study of the action of drugs. It is therefore obvious that the title should read Chemistry and Pharmacology of Alkaloids.

The arrangement of the material in such chapters has several drawbacks. First, the various properties of alkaloids are discussed in different chapters and some are not discussed at all. This makes it difficult, if not impossible, to get a complete picture of the pharmacology and the pharmacodynamic action of a specific compound. This difficulty is only partly overcome by a subject index that lists the pages on which various phases of one compound are discussed. Second, the various chapters are prepared by different authors, and as a consequence the arrangement of the material is not uniform. Some authors stress the clinical aspects and others stress the pharmacodynamic action. For some alkaloids the toxicity is hardly discussed, whereas for others toxicity data are presented. It is obvious that such data are very essential for the pharmacological picture of any compound.

The book is well printed and bound and it contains few typographical errors, the most disturbing being "conine" instead of "coniine," which is not only repeatedly misspelled in the text but also in the subject index. The book has definite limitations as a source for information on the pharmacological properties of alkaloids.

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Poliomyelitis. Papers and discussions presented at the third International Poliomyelitis Conference. International Poliomyelitis Congress. Lippincott, Philadelphia, Pa.–Montreal, Canada, 1955. 567 pp. Illus.

The scientific papers that make up the bulk of this extensively illustrated conference report are grouped under the following headings: social aspects of poliomyelitis, acute medical care in poliomyelitis, infection and immunity in poliomyelitis, developments in tissue culture, orthopedics, physical medicine and rehabilitation, and trends in poliomyelitis. The scientific exhibits at the conference are also described. The conference was held in Rome in September 1954. Thirty-nine countries were represented by delegates.

Books Reviewed in The Scientific Monthly, May

The Viking Rocket Story, M. W. Rosen (Harper). Reviewed by H. Yagoda.

Culture and Experience, A. I. Hallowell (Univ. of Pennsylvania Press). Reviewed by I. L. Child.

Science and Man's Hope, J. S. Fulton (Bookman). Reviewed by H. L. Shapiro.

Man's Emerging Mind, N. J. Berrill (Dodd, Mead). Reviewed by L. J. and M. Milne.

Culture and Mental Disorders, J. W. Eaton and R. J. Weil (Free Press). Reviewed by M. B. Loeb.

Scientific Writing, M. R. Emberger and M. R. Hall (Harcourt, Brace). Reviewed by R. L. Zwemer.

Treatise on Invertebrate Paleontology, pt. E, R. C. Moore, Ed. (Univ. of Kansas Press; Geological Society of America). Reviewed by J. Imbrie.

The Life and Work of Sigmund Freud, vol. 2, E. Jones (Basic Books). Reviewed by R. R. Holt.

Principles of Mathematics, C. B. Allendorfer and C. O. Oakley (McGraw-Hill). Reviewed by H. F. Fehr.

The Sun and Its Influence, M. A. Ellison (Macmillan). Reviewed by D. ter Haar.

Standing Room Only, K. Sax (Beacon). Reviewed by P. S. Henshaw.

Antimetabolites and Cancer, C. P. Rhoads (American Association for the Advancement of Science). Reviewed by E. F. Osserman.

Marine Shells of the Western Coast of Florida, L. M. Perry and J. S. Schwengel (Paleontological Research Institution). Reviewed by H. A. Rehder.

New Books

Psychology: the Fundamentals of Human Adjustment. Norman L. Munn. Houghton Mifflin, Boston, ed. 3, 1956. 542 pp. $5.75.

Essays on Science. Herman Augustus Spoehr. Foreword by C. Stacy French, contributions by Alexander Spoehr, Hortense Spoehr Miller, and James H. C. Smith and a bibliography compiled by Wilbur A. Pestell. Stanford University Press, Stanford, Calif., 1956. 220 pp. $5.

Electronics in Management. Lowell Hattery and George P. Bush. University Press of Washington, D.C., 1956. 207 pp. $6.

The Butterflies of Southern Africa. pt. II, *Nymphalidae: Danainae and Satyrinae*. G. Van Son. Transvaal Museum Pretoria, S.A., 1955. 166 pp.

Progress in Neurobiology. I, *Neurochemistry*. Saul R. Korey, and John I. Nurnberger, Eds. Hoeber-Harper, New York, 1956. 244 pp. $6.75.

Surveys in Mechanics. A collection of surveys of the present position of research in some branches of mechanics, written in commemoration of the 70th birthday of Geoffrey Ingram Taylor. G. K. Batchelor and R. M. Davies, Eds. Cambridge University Press, Cambridge, 1956. 475 pp. $9.50.

Miscellaneous Publications

(Inquiry concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

Hydro-Electricity and Nature Protection. Stating the case. vol. II. Prepared by Lord Hurcomb. Union Internationale pour la Protection de la Nature, Brussels, 1955. 224 pp.

Expert Committee on Drugs Liable to Produce Addiction. Sixth report. WHO Tech. Rept. Ser., 102. World Health Organization, Geneva, 1956. 21 pp. $0.30.

Some Amphibians from the Lowlands of North Borneo. Fieldiana: Zoology, vol. 34, No. 36. Robert F. Inger. 36 pp. $0.75. *Notes on a Collection of Fishes from Southeastern Venezuela*. vol. 34, No. 37. Robert F. Inger. 16 pp. $0.30. Chicago Natural History Museum, Chicago, 1956.

Institut pour la Recherche Scientifique en Afrique Centrale, Sixieme Rapport Annuel, 1953. The Institute, Brussels, 1956. 229 pp.

Current Biography. Who's news and why. vol. 17, No. 4. H. W. Wilson, New York 52, 1956. 64 pp. $0.50.

Constituents of Bacteriological Culture Media. A review of information available on methods of manufacture prepared by the Standardization Subcommittee on the Society for General Microbiology. Spec. Rept. G. Sykes, Ed. Cambridge University Press, Cambridge, England, 1956 (order from Cambridge University Press, New York). 32 pp. $1.

Space Requirements of the Seated Operator. Geometrical, kinematic, and mechanical aspects of the body with special reference to the limbs. WADC Tech. Rept. 55-159. Wilfred T. Dempster. Wright Air Development Center, Wright-Patterson Air Force Base, Ohio, 1955 (order from Office of Technical Services, U.S. Dept. of Commerce, Washington 25). 254 pp.

Land Acquisition, 1955. Highway Research Board Bull. 113. 1956. 83 pp. $1.80. *Design and Testing of Flexible Pavement*. Bull. 114. 1955. 87 pp. $1.65. National Academy of Sciences–National Research Council, Washington.

Carnegie Institution of Washington, Yearbook No. 54. 1 July 1954–30 June 1955. With administrative reports through 9 December 1955. 311 pp. Paper, $1; cloth, $1.50. *Lines of the Chemical Elements in Astronomical Spectra*. Publ. 610. Paul W. Merrill. 1956. 167 pp. Paper, $1.60; cloth, $2. Carnegie Institution of Washington, Washington, D.C.

Migration and Mental Disease. A study of first admissions to hospitals for mental disease, New York, 1939–1941. Benjamin Malzberg and Everett S. Lee. Social Science Research Council, New York, 1956. 142 pp. $1.50.

Taxonomic Appraisal and Occurrence of Fleas at the Hastings Reservation in Central California. Publ. in Zoology, vol. 54, No. 5. Jean M. Linsdale and Betty S. Davis. 78 pp. $1.50. *The Frankliniella Occidentalis (Pergande) Complex in California (Thysanoptera: Thripidae)*. Publ. in Entomology, vol. 10, No. 6. Douglas E. Bryan and Ray F. Smith. 52 pp. $0.75. University of California Press, Berkeley and Los Angeles, 1956.

Scientific Meetings

Meeting Notes

■ The 36th annual meeting of the Society of American Military Engineers will be held in Washington, D.C., 14–16 May. The Army Engineer Center, the Engineer School, and the Engineer Research and Development Laboratories at Fort Belvoir, Va., will be hosts to the society on 14 May. On the morning of 15 May, the Department of Defense will conduct an industrial mobilization symposium at the Mayflower Hotel.

■ A variety of subjects related to research and testing of engineering materials will be discussed at the 59th annual meeting of the American Society for Testing Materials to be held in Atlantic City, N.J., 17–22 June. Some 31 sessions have been scheduled. There will be eight symposia on the following subjects: specific gravity of bituminous-coated aggregates, ion exchange and chromatography in analytic chemistry, solder, *p*H measurement, tension testing of nonmetallic materials, steam quality, rheology, and in-place shear testing of foundation soil by the Vane method. During the technical sessions there will be papers on metals, concrete, fatigue, stainless steel, soils, and general testing.

This year the Marburg lecture will be given by Charles E. Reed of the General Electric Company, Waterford, N.Y., on the "Chemical properties, and applications of silicones." D. K. Crampton of the Chase Brass and Copper Company, Waterbury, Conn., will give the Gillette memorial lecture on the "Structural chemistry and metallurgy of copper."

The society's 12th Exhibit of Testing and Scientific Apparatus and Laboratory Supplies will be on display. This exhibit is held every other year.

■ A Symposium on Recent Developments in Research Methods and Instrumentation will be held at the National Institutes of Health, Bethesda, Md., 14–16 May. The five sessions will cover the following subjects: structure of proteins, spectrochemistry, vapor-phase chromatography, radioactive counting methods, and methods for the study of individual living cells. The symposium is being held in conjunction with the sixth annual Research Equipment Exhibit. A complete listing of papers is available. For information, write to the chairman of the Symposium Committee, Roger G. Bates, at NIH.

■ A conference on Magnetism and Magnetic Materials, sponsored by the American Institute of Electrical Engineers in cooperation with the American Physical Society, the American Institute of Mining and Metallurgical Engineers, and the Institute of Radio Engineers, will be held in Boston on 16 Oct. Authors should submit titles of proposed papers *by 15 June* and abstracts *by 1 Aug.* For further details write: T. O. Paine, Measurements Laboratory, General Electric Company, West Lynn, Mass.

■ The Italian Physical Society has announced that the International School of Physics is to be held in Varenna, Lake Como, 15 July–4 Aug. This year the course will be devoted to the magnetic properties of matter. Among the lecturers scheduled are C. Kittel of the University of California, and E. M. Purcell and J. H. Van Vleck of Harvard University.

Society Elections

■ American Psychosomatic Society: pres., I. Arthur Mirsky; pres.-elect, Theodore Lidz; sec.-treas., Morton F. Reiser.

■ Tennessee Academy of Science: pres., Claude S. Chadwick, George Peabody College for Teachers; pres.-elect, Isabel H. Tipton, University of Tennessee; secy., Donald Caplener, George Peabody College for Teachers; treas., Harris J. Dark, David Lipscomb College. Representative to the AAAS Council is Clinton L. Baker.

■ American Society of Photogrammetry: pres., William C. Cude; first v. pres., K. E. Reynolds; second v. pres., Harry Tubis; sec.-treas., C. Earl Palmer.

■ Pennsylvania Academy of Science: pres., Richmond E. Myers, Moravian College; pres.-elect, Robert B. Gordon, State Teachers College (West Chester); v. pres. (East), John J. Heilemann, Ursinus College; v. pres. (West), Dwight E. Sollberger, Indiana State Teachers College; sec.-treas. and representative to the AAAS Council, Kenneth Dearolf, Public Museum and Art Gallery, Reading.

Forthcoming Events

June

1. Metal Metabolism and Microbiological Deterioration Conf., Washington, D.C. (C. J. Wessel, National Research Council, 2101 Constitution Ave., NW, Washington 25.)

3–6. American Soc. of Refrigerating Engineers, Cincinnati, Ohio. (R. C. Cross, ASRE, 234 Fifth Ave., New York 1.)

3–7. Special Libraries Assoc., annual, Pittsburgh, Pa. (Miss M. E. Lucius, 31 E. 10 St., New York 3.)

4–7. Forest Products Research Soc., Asheville, N.C. (F. J. Rovsek, FPRS, P.O. Box 2010, University Station, Madison 5, Wis.)

4–8. American Soc. of Civil Engineers, national conf., Knoxville, Tenn. (W. H. Wisely, ASCE, 33 W. 39 St., New York 18.)

4–9. International Mechanical Engineering Cong., 6th, Paris, France. (British Engineers Assoc., 32 Victoria St., London, S.W.1, England.)

4–9. International Seed Testing Convention, Paris, France. (C. Stahl, International Seed Testing Assoc., Thorvaldsensvej 57, Copenhagen V, Denmark.)

4–9. Microbiological Inst., 9th annual, Lafayette, Ind. (Div. of Adult Education, Engineering Administration Bldg., Purdue Univ., Lafayette.)

6–8. American Soc. for Quality Control, annual, Montreal, Quebec, Canada. (C. E. Fisher, ASQC, Room 563, 50 Church St., New York 7.)

6–9. European Federation for Chemical Engineering, 9th, Frankfurt/Main, Germany. (Dechema-Haus, Rheingau-Allee 25, Frankfurt A.M.)

6–10. American College of Chest Physicians, annual, Chicago, Ill. (M. Kornfeld, ACCP, 112 E. Chestnut St., Chicago.)

7–9. Endocrine Soc., annual, Chicago, Ill. (H. H. Turner, 1200 N. Walker St., Oklahoma City, Okla.)

9–10. Soc. for Investigative Dermatology, annual, Chicago, Ill. (H. Beerman, 255 S. 17 St., Philadelphia 3, Pa.)

10–14. Institute of Food Technologists, annual, St. Louis, Mo. (C. S. Lawrence, IFT, 176 W. Adams St., Chicago 3, Ill.)

10–15. American Crystallographic Assoc., French Lick, Ind. (S. Siegel, Chemistry Div., Argonne National Lab., Box 299, Lemont, Ill.)

11–15. American Medical Assoc., annual, Chicago, Ill. (G. F. Lull, AMA, 535 N. Dearborn St., Chicago 10.)

11–15. Symposium on Molecular Structure and Spectroscopy, annual, Columbus, Ohio. (H. H. Nielsen, Dept. of Physics, Ohio State Univ., Columbus.)

11–16. Pacific Div., AAAS, Seattle, Wash. (R. C. Miller, California Acad. of

Sciences, Golden Gate Park, San Francisco 18.)

11–23. European Organization for Nuclear Research, Symposium on High Energy Physics, Geneva, Switzerland. (H. Coblans, CERN, Case Postale 25, Genève 15-Aéroport.)

12. National Assoc. of Science Writers, annual, Chicago, Ill. (M. L. Silverman, NASW, 4 Bassett Lane, Atherton, Calif.)

12–14. American Meteorological Soc., Seattle, Wash. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)

12–15. Max Planck Soc. for Advancement of Sciences, Stuttgart, Germany. (Max Planck Soc., Raiserswerther Str. 164, Düsseldorf 22a, Germany.)

12–16. World Conference on Earthquake Engineering, Berkeley, Calif. (R. W. Clough, Div. of Civil Engineering, Univ. of California, Berkeley 4.)

13–14. Conference for Veterinarians, 25th annual, Columbus, Ohio. (J. W. Helwig, College of Veterinary Medicine, Ohio State Univ., Columbus 10.)

13–16. Colloquium of College Physicists, annual, Iowa City, Iowa. (G. W. Stewart, Dept. of Physics, State Univ. of Iowa, Iowa City.)

16–17. Council of American Bioanalysts, Dallas, Tex. (M. F. Dooley, 308 S. Bishop, Dallas, Tex.)

17–20. American Soc. of Agricultural Engineers, 49th annual, Roanoke, Va. (F. B. Lanham, ASAE, St. Joseph, Mich.)

17–22. American Soc. of Medical Technologists, annual, Quebec, Canada. (Miss R. Matthaei, Suite 25, Hermann Professional Bldg., Houston 25, Tex.)

17–22. American Soc. for Testing Materials, annual, Atlantic City, N.J. (R. J. Painter, ASTM, 1916 Race St., Philadelphia 3, Pa.)

17–23. American Library Assoc., annual, Miami Beach, Fla. (D. H. Clift, 50 E. Huron St., Chicago 11, Ill.)

17–23. World Confederation for Physical Therapy, 2nd international cong., New York, N.Y. (Miss M. Elson, American Physical Therapy Assoc., 1790 Broadway, New York 19.)

17–23. World Power Conf. (invitational), 5th plenary, Vienna, Austria. (S. E. Reimel, Engineers Joint Council, 29 W. 39 St., New York 18.)

17–30. West Coast Science Teachers Summer Conf., Corvallis, Oreg. (R. H. Carleton, National Science Teachers Assoc., 1201 16 St., NW, Washington 6.)

18–20. American Neurological Assoc., 81st annual, Atlantic City, N.J. (C. Rupp, ANA, 133 S. 36 St., Philadelphia 4, Pa.)

18–20. American Soc. of Heating and Air-Conditioning Engineers, Washington, D.C. (A. V. Hutchinson, ASHAE, 62 Worth St., New York 13.)

18–21. Institute of Aeronautical Sciences, Inc., annual summer, Los Angeles, Calif. (S. P. Johnston, 2 E. 64 St., New York 21.)

18–21. Phi Lambda Upsilon, triennium convention, Ann Arbor, Mich. (T. B. Cameron, Dept. of Chemistry, Univ. of Cincinnati, Cincinnati 21, Ohio.)

18–22. American Physical Therapy Assoc., annual, New York. (Miss M. Elson, APTA, 1790 Broadway, New York 19.)

18–22. Medical Library Assoc., 55th annual, Los Angeles, Calif. (A. N. Brandon, Library, College of Medical Evangelists, Loma Linda, Calif.)

18–24. Acoustical Soc. of America, Cambridge, Mass. (W. Waterfall, ASA, 57 E. 55 St., New York 22.)

19–22. American Dairy Science Assoc., annual, Storrs, Conn. (H. F. Judkins, 32 Ridgeway Circle, White Plains, N.Y.)

20–21. Symposium on Diffusion and Flow Processes in Polymers, Madison, Wis. (W. J. Lyons, Quartermaster Research and Development Command, Natick, Mass.)

20–22. American Assoc. of Physics Teachers, annual, Toronto, Ont., Canada. (F. Verbrugge, Carleton College, Northfield, Minn.)

20–22. Ciba Foundation Symposium on Endocrinology (invitational), London, England (G. E. W. Wolstenholme, 41 Portland Place, London, W.1.)

20–28. International Union for the Protection of Nature, Edinburgh, Scotland. (J. P. Harroy, IUPN, 42, rue Montoyer, Brussels, Belgium.)

21–23. American Physical Society, New Haven, Conn. (K. K. Darrow, Columbia Univ., New York 27.)

21–23. American Physical Society, Eugene, Ore. (W. A. Nierenberg, Univ. of California, Berkeley 4.)

21–23. Soc. of Nuclear Medicine, annual, Salt Lake City, Utah. (R. G. Moffat, 2656 Heather St., Vancouver 9, Canada.)

21–24. American Acad. of Dental Medicine, 10th annual, Detroit, Mich. (G. J. Witkin, AADM, 45 S. Broadway, Yonkers 2, N.Y.)

21–24. American Soc. of Ichthyologists and Herpatologists, 36th annual, Higgins Lake, Mich. (R. M. Bailey, Museum of Zoology, Univ. of Michigan, Ann Arbor.)

25–27. Symposium on Uses of High Temperatures in Science and Industry, Berkeley, Calif. (N.K. Hiester, Stanford Research Inst., Menlo Park, Calif.)

25–29. American Soc. for Engineering Education, annual, Ames, Iowa. (W. Leighton Collins, Univ. of Illinois, Urbana.)

25–29. American Inst. of Electrical Engineers, Summer and Pacific General, San Francisco, Calif. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

25–29. Alpha Chi Sigma Fraternity, biennial convention, University Park, Pa. (J. R. Kuebler, 5503 E. Washington St., Indianapolis 19, Ind.)

25–29. International Cong. on Physio-Pathology of Animal Reproduction and of Artificial Insemination, 3d, Cambridge, England. (J. Edwards, Production Div., Milk Marketing Board, Thames Ditton, Surrey, England.)

25–30. International Assoc. for Bridge and Structural Engineering, 5th cong., Lisbon, Portugal. (M. L. Gretner, Swiss Federal Inst. of Technology, Zurich.)

26–29. American Home Economics Assoc., annual, Washington, D.C. (Miss M. Horton, AHEA, 1600 20 St., NW, Washington 9.)

28–1. International Scientific Conf. of Rheumatism, Aix-les-Bains, France. (M. Graber-Duvernay, 6, rue de Liege, Aix-les-Bains.)

(See issue of 20 April for comprehensive list)

Kodak reports to laboratories on:

a reagent for determining α-keto acids in blood and urine . . . a movie camera for high altitudes and latitudes . . . how goodly the body of microprint literature is

Clarion call from Stoke Poges

Far from the madding crowd's ignoble strife and to the eternal boredom of sophomores, a man named Thomas Gray published in 1751 some thoughts about Life inspired by the country churchyard of Stoke Poges in Buckinghamshire. From the same town, exactly 200 years later, two other individuals whose thoughts about Life were more along the line of what part α-keto acids might play in it, sent to the editor of *The Biochemical Journal* (*52*,38) a paper in which they introduced 1,2-diamino-4-nitrobenzene as a reagent for these acids, proclaiming it more specific than the previous favorite, 2,4-dinitrophenylhydrazine, because it forms stable nitroquinoxalinols which may be separated by paper chromatography.

Actually this new reagent has been slumbering peacefully in our catalog for the past 16 years ever since we began making it as an intermediate toward a benzimidazole. A change of name in the interim toward the *Chemical Abstracts* form, *4-Nitro-o-phenylenediamine* (Eastman 4323), has made the grave a little harder to find. Now the clarion call from Stoke Poges, reinforced by an abstract we offer of a paper in *The Analyst* for August '55 on the use of the reagent in detecting and determining α-keto acids in blood and urine, brings life again to the old amine.

Your order for 25 grams of Eastman 4323 at $2.50 and a note asking for the abstract is all it takes to try this new reagent. It's one of some 3500 Eastman Organic Chemicals we stock. Distillation Products Industries, Eastman Organic Chemicals Department, Rochester 3, N. Y. (Division of Eastman Kodak Company).

K-100 in the cold

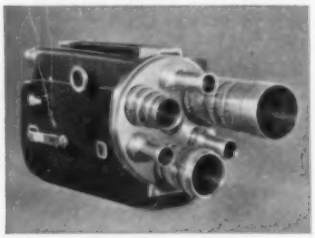
"Walt Disney Productions' Antarctic film will soon be shown on the Disneyland and Mickey Mouse Club TV Shows and will be released as a full-length movie which can be seen at your local movie theatre."

Printing the above sentence seems a fair price to pay for the privilege of saying that the *Cine-Kodak K-100 Cameras* of the Disney crews in Antarctica are functioning properly at −45F without the electric blankets which far costlier 16mm movie cameras require.

Actually, nowadays, smart outfits like the Disney organization find out from an environmental chamber test in advance just what they can or cannot expect from equipment being considered for strenuous duty. Then you hear from them only if the equipment failed to perform as in the test, in which case you hear plenty.

We could attribute the low-temperature performance of this camera to the extra care lavished by aging craftsmen on each *K-100* that leaves their devoted hands. A more credible explanation is afforded by the nylon gears, nylon pulldown cam, and the ball-bearing pulldown mechanism. The pre-stressed spring motor is also of some pertinence to the matter.

The *K-100* is now made in a turret model like this:



Those smaller tubes opposite each of the three *Kodak Cine-Ektar Lenses* contain their respective viewfinder telescope objectives. No Disney tie-in, unfortunately, because this model came out months after the Mickey Mouse emissaries shoved off.

Performance of the K-100 *in the cold should be just as exploitable at high altitudes as at high latitudes. Data recording, for example? A Kodak dealer is nearby.*

A snowball rolling

Somewhere your librarian has to draw the line. Some books and bound volumes simply cost too much in money and space for the good a given organization is likely to get from them. These words are promotion for the microprint idea. It pushes the line which your librarian has to draw about as far as anyone could want it pushed.

A microprint card* is a piece of stiff paper, generally 3″ x 5″ or larger, on which can appear as many as 60 greatly reduced book pages. These cards are read with the aid of optical devices. Of these we are prejudiced in favor of the *Kodagraph Microprint Reader* as the most comfortable to use.

A goodly body of the technical literature in the sciences, the humanities, and even the law and finance is now on sale in this form. To illustrate just how goodly is the body, we have just published a booklet entitled "What's Available on Microprint Cards." It is an attempt at a condensed consolidated catalog of the output of all microprint card publishers known to us and willing that we publicize their offerings. We alone are footing the bill for this project.

Our motives, of course, are selfish. Our scheme with the booklet is to convince a lot more scholars, librarians, and librarians' bosses that there is enough microprint literature around to justify the acquisition of microprint readers. Then, just as surely as the telephone, radio, and television industries grew, microprint grows. The publisher's market grows. The number of titles grows. The need for microprint readers where researchers foregather becomes more obvious. It even occurs to more large companies that since their research people already have readers for the open microprint literature, the companies' own internal reports might be more efficiently circulated in microprint form.

Since, as all this comes to pass, we shall sell more and more photographic materials with which to make microprint cards, there is no reason to hesitate about writing for a free copy of "What's Available on Microprint Cards" to Eastman Kodak Company, Graphic Reproduction Division, Rochester 4, N. Y.

*The term "Microcard" is applied only to certain makes of microprint cards.

Price quoted is subject to change without notice.

This is one of a series of reports on the many products and services with which the Eastman Kodak Company and its divisions are . . . *serving laboratories everywhere*

Kodak
TRADEMARK

Equipment News

■ THROW-AWAY PETRI DISHES for use in the microbiological laboratory are sterile and pyrogen-free. They are made of optically clear styrene plastic with a heat-distortion point of 90°C, a material that is inert to biological reagents. (Chicago Apparatus Co., Dept. Sci., 1735 N. Ashland Ave., Chicago 22, Ill.)

■ INFRARED SPECTROPHOTOMETER model IR-4, by Beckman, incorporates a double monochromator for spectral purity and high resolution. It may be operated on a double-beam system for quick scans and convenient data presentation, or on a single-beam system for greater quantitative accuracy in chemical analyses. (Beckman Instruments, Inc., Dept. Sci., Fullerton, Calif.)

■ X-RAY DIFFRACTION INSTRUMENT model XRD-5, by General Electric, utilizes a high-speed proportional counter and preamplifier that frees x-ray diffraction techniques from dependence on conventional Geiger counters and permits accurate, rapid analyses. A single-crystal orienting device permits analytic chemists and physics researchers to analyze fibers and wires and to study preferred orientations by the reflection method. Direct count of line area, even for intense, wide lines, can be made at rates exceeding 100,000 counts/sec, with a count capacity of 100 million. The preamplifier enables the detector to perform linearly in a range about 5 times greater than is possible with multichamber Geiger counter assemblies. A helium atmosphere is substituted for air in quantitative determinations of widely known elements of small atomic number. (General Electric Co., Dept. Sci., 4855 Electric Ave., Milwaukee 1, Wis.)

■ OSCILLOSCOPE designed specifically for biological use can monitor physiological processes visibly. Called the Viso-scope, it is exceptionally simple to operate and utilizes a minimum of controls. The unit can be used to view several phenomena simultaneously or alternately by means of a selector switch. Provision for attachment to a recording system has been included. (Sanborn Instrument Co., Dept. Sci., 37 Sanborn St., Cambridge 39, Mass.)

■ ULTRAVIOLET LIGHT ABSORBERS are described in a 20-page booklet published by Antara Chemicals. The absorption characteristics, compatibility in plastics, colors, and other properties of four substituted benzophenones are discussed. Two new products that are used to control harmful effects of ultraviolet radiations are described. (Antara Chemicals, Dept. Sci., 435 Hudson St., New York 14)

■ HISTOLOGICAL FREEZE DRYER is designed to simplify routine preparation of tissues for sectioning and for microchemical and optical studies. The unit can run up to eight sections at one time and is equipped with an individual chamber for evacuating the imbedding medium. Several units may be operated simultaneously from one vacuum pump. Drying time for most tissues is less than 6 hr at temperatures of – 40°C bath and – 78°C condenser. (E. Machlett and Son, Dept. Sci., 220 E. 23 St., New York 10)

■ TECHNICAL DATA on analysis, preparation, properties, and applications of molybdenum chemicals is available in 68 papers that have been published by Climax Molybdenum. A recently compiled catalog of these bulletins lists several on cyanomolybdates, halides and oxyhalides of molybdenum, organic complexes of molybdenum, heteropolymolybdates, and molybdenum disulfide that are included in a new series prepared for Climax by the Battelle Memorial Institute. (Climax Molybdenum Co., Dept. Sci., 500 5th Ave., New York 36)

■ SOURCE AND MICROWAVE EXCITER, used in high-dispersion interferometry, makes wavelength determinations with accuracies to 1 part/million. Baird's mercury-198 model utilizes a fused quartz electrodeless lamp containing about 0.4 mg of Hg^{198} prepared by transmutation of gold. The portable exciter unit operates at a 12.2-cm wavelength and is powered by a 60-cy/sec, 115-v alternating-current supply. (Baird Associates, Inc., Dept. Sci., 33 University Rd., Cambridge 38, Mass.)

■ THREE ETHANOLAMINES are discussed in a 48-page booklet recently published by the Nitrogen Division of Allied Chemical and Dye. Included are physical property graphs and information on applications and specifications of these substances, as well as data on their physical, chemical, and physiological properties. (Allied Chemical and Dye Corp., Dept. Sci., 40 Rector St., New York 6)

■ CATHODE-RAY TUBE retains traces on its screen for investigation. Operator can erase the screen when pictures have been studied or photographed. The tube has potential applications for electroencephalographic and cardiographic studies and may be of service in geophysics, instrumentation, and computer reading. (Hughes Aircraft Co., Dept. Sci., Culver City, Calif.)

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POSITIONS WANTED

Botanist, Ph.D. Twelve years' teaching and research experience in general botany and ecology. Publications. Desires academic position. Box 105, SCIENCE. 5/4

Botany, Microbiology; Ph.D., woman, publications, Sigma Xi; 9 years' teaching experience in university. Would prefer college in north-central region. Box 116, SCIENCE. X

Instructor; B.S., M.S. (major, zoology; minor, botany); Ph.D. (education major); 4 years, part-time teaching, 5 years' full-time teaching in biological areas plus experience in teaching basic sciences to student nurses in college affiliated programs. Medical Bureau (Burneice Larson, Director), Palmolive Building, Chicago. X

Science Teacher, M.A., Columbia University; 2 years' experience. Desires high-school position—physics, chemistry and/or biology. Or teaching of biology in college. Box 109, SCIENCE. X

POSITIONS WANTED

Fishery Biologist, Ph.D.; 12 years' teaching and research experience. Seeks position with university or government. Box 111, SCIENCE. X

Microbiologist–Biochemist, Ph.D. Several years' research experience in microbial nutrition and metabolism, laboratory and Pilot plant scale; manometric and tracer techniques, bio-assay, chromatography; presently employed. Box 94, SCIENCE. 13, 20, 27 Apr.; 4 May

Zoologist–Parasitologist, Ph.D. Seven years teaching parasitology, entomology, limnology, and related courses. Desires teaching, field work, or research position where additional experience is more important than salary. Box 99, SCIENCE. 5/4

POSITIONS OPEN

Biochemistry, Assistant Professorship. Duties: teaching and research. Send full information concerning teaching and research experience to Chairman, Department of Biochemistry, Faculty of Medicine, Dalhousie University, Halifax, N.S., Canada. X

DIRECTOR — PHARMACEUTICAL RESEARCH. To direct research program for new division of nationally known proprietary drug company. Location, northern New Jersey. **Requirements:** Ph.D. in pharmacy or pharmaceutical chemistry (undergraduate degree in pharmacy preferred); 3 to 5 years' industrial experience; must enjoy working "at the bench" as well as providing creative direction to subordinates.

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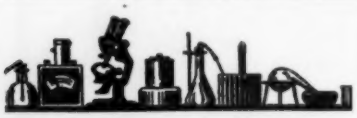

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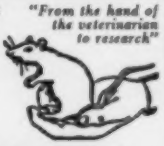

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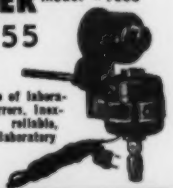

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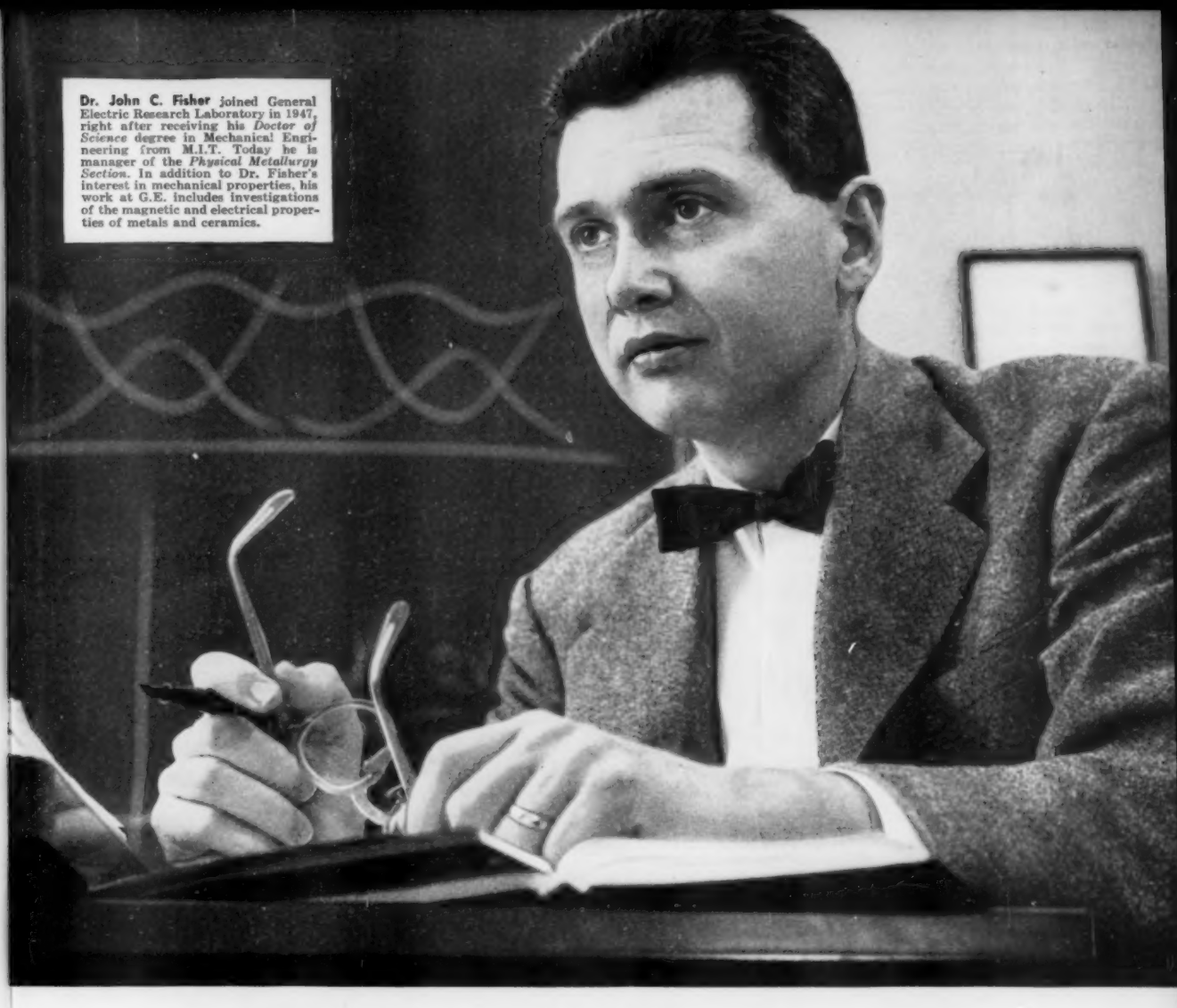

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